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NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

**WAN OPTIMIZATION: A BUSINESS PROCESS
REENGINEERING AND KNOWLEDGE VALUE ADDED
APPROACH**

by

Aaron Delano Sanders

March 2011

Thesis Advisor:
Second Reader:

Glenn Cook
Thomas Housel

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**WAN OPTIMIZATION: A BUSINESS PROCESS REENGINEERING AND
KNOWLEDGE VALUE ADDED APPROACH**

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ABSTRACT

Wide Area Networks (WAN) have become more prevalent with the expansion of global organizations. WANs have provided more geographical flexibility, shared resources, and have even eased the workload in most organizations when performing at optimal levels. Historically, however, such IT configurations have not been found to provide a measurable level of productivity despite the rapid advances in computing technology. This shortfall has prompted decision makers to explore the Knowledge Value Added (KVA) aspects of IT solutions to define the true return on investment associated with each adoption. The purpose of this study is to evaluate the impact of Cascade, a WAN optimization tool, within the context of the C4I helpdesk model. The actual repair portion of the WAN is beyond the scope of this research; however, the technical support process from notification to corrective action has been modeled and then reengineered to demonstrate the KVA benefits in optimizing the WAN with Cascade and Steelhead products made available through Riverbed Technology.

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LIST OF ACRONYMS AND ABBREVIATIONS

ALT	-	Actual Learning Time
AOA	-	Alternative of Analysis
BPR	-	Business Process Reengineering
CBR	-	Case Based Reasoning
COTS	-	Commercial Off-the-Shelf
CTR	-	Cooperative Threat Reduction
DCF	-	Discounted Cash Flow
DEN	-	Denominator
DoD	-	Department of Defense
DoDI	-	Department of Defense Instruction
DTS	-	Defense Travel System
EMD	-	Engineering Manufacture Development
FRP	-	Full Rate Production
FTP	-	File Transfer Protocol
HTML	-	Hyper-text Markup Language
HTTP	-	Hyper-text Transfer Protocol
IDC	-	International Data Corporation
IP	-	Internet Protocol
IRR	-	Internal Rate of Return
ISC	-	Information System Coordinator
IT	-	Information Technology
ITIL	-	Information Technology Infrastructure Library
KM	-	Knowledge Management
KPP	-	Key Performance Parameter
KVA	-	Knowledge Value Added
LRIP	-	Low Rate Initial Production
MAC	-	Move/Add/Change
MCCDC	-	Marine Corps Combat Development Command

MCCS	-	Marine Corps Community Services
MDA	-	Material Development Decision
MSGB	-	Marine Security Guard Battalion
MTBF	-	Mean Time Between Failures
MTTR	-	Mean Time To Repair
NET	-	NMCI Enterprise Tool
NLT	-	Nominal Learning Time
NMCI	-	Navy Marine Corps Intranet
NPV	-	Net Present Value
NUM	-	Numerator
OSI	-	Open System Interconnect
PECA	-	Plan Evaluation, Establish Criteria, Collect Data, Analyze
PV	-	Present Value
QOS	-	Quality of Service
ROI	-	Return on Investment
ROK	-	Return on Knowledge
RPC	-	Remote Procedure Call
SEI	-	Software Engineering Institute
SMTP	-	Simple Mail Transfer Protocol
SOA	-	Service Oriented Architecture
SQL	-	Structure Query Language
SRM	-	Service Request Management
SWAN	-	Support Wide Area Network
TCP	-	Transmission Control Protocol
TLT	-	Total Learning Time
UDP	-	User Datagram Protocol
USMC	-	United States Marine Corps
VPN	-	Virtual Private Network
WAAS	-	Wide Area Application Services
WAN	-	Wide Area Network

EXECUTIVE SUMMARY

The author's area of research is assessing the knowledge value added for information systems in relation to the reengineering of a business process. Cascade is a uniquely integrated network assessment and acceleration solution, combining network and application visibility with the Wide Area Network (WAN) optimization benefits of Riverbed Steelhead appliances. The intention of this thesis is to determine, through the simulation of a help desk and WAN, whether the Cascade IT solution is a viable concept that is able to realize a true return on investment. This return on investment would be achievable through the consolidation or reduction in physical infrastructure and personnel, and the increase in knowledge value that Cascade provides to process troubleshooting activities at the help desk.

The method of using knowledge to evaluate and value a system is a relatively new concept, but one that is imperative to determine the true return on investment any information-based system can and most likely will realize. Since the Department of Defense is a nonrevenue generating organization, it is imperative that some value for return on investment be determined and hedged against products or organizations of similar nature for comparison purposes.

Knowledge resides primarily within human heads. By delving into the processes associated with the implementation and operation of networks, both traditionally and virtually, we will be able to determine the value versus cost of knowledge assets, determine the value of the intangible assets, and completely understand the organization as it pertains to knowledge.

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The Naval Postgraduate School program is a privilege, an academic opportunity, but education is earned and never given!

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I. INTRODUCTION

A. PROBLEM STATEMENT

In the years following the financial collapse of 2008, the Department of Defense (DoD) has been faced with making unprecedented budget cuts. No longer can the DoD afford to fund countless programs without first proving a measure of success in a return on investment. All acquisition programs must be reevaluated to determine the worthiness of continuing to fund losing efforts.

The responsibility to provide value in information technology (IT) programs has been paramount, since they historically fail to produce the desired effort. The DoD has to abandon funding these projects if they do not return a sizeable monetary gain. They must verifiably determine the ROI or knowledge value aspects to support full implementation. The purpose of this research is to outline an effective way of demonstrating the value of an IT solution prior to adoption.

The continuously developing technology has introduced many new challenges in the network performance domain due to the growth and expandability of the networks, either because of the addition of new users or because of the necessity for integration, and thus, interoperability between different systems (both new and legacy ones). Therefore, the consistency and high-level performance of the network, along with the elimination of security vulnerabilities, are some of the inquiries that IT personnel are forced to address immediately and sometimes drastically.

An organization's operational posture can be directly related to its operational sophistication. Most companies struggle with taking network operations from a reactive to a proactive paradigm. The level of sophistication can be improved by moving beyond day-to-day reactive needs and looking at network operations holistically.

This means taking a higher-level view of the network life cycle encompassing preparation, planning, design, implementation, operations, and optimization—ensuring that the entire life cycle addresses people, processes, and technology and how they are combined to deliver agile network services. The goal is to increase the network's

responsiveness to business needs and maximize the business investment in the network infrastructure and resources, while ensuring that the network scales and that those services are provided accurately and reliably.

1. Business Profile

Riverbed Technology is one of the latest companies that specializes in network management and IT performance improvement providing flexible and scalable systems with smart technology implementation. Due to limitations on the scope of this thesis, the analysis of network management systems will be limited to a single entity. There are competitors in the market that provide similar functionality as Riverbed Cascade and may be suitable substitutes for the application addressed in this paper. The analysis of Riverbed Cascade is in no way considered to be an endorsement of the company or its products over any of its competitors.

More in-depth, Riverbed Technology is an enterprise-wide visibility solution, covering all data centers, offices, and mobile users. It collects network traffic data from devices such as switches and routers, and uses this data to discover applications and evaluate their performance. It uses behavioral analytics to track performance over time and alert users to any deviations from normal behavior. This gives technicians the flexibility to resolve problems before end-users are impacted.

2. Organizing Logic

The military environment, especially the one that characterizes the nature of the United States Marine Corps tasks, is highly time-agile due to the limited time availability to respond in any kind of mission, with high environmental turbulence due to the variety of the quality and quantity of the missions and their its participation. In addition, due to financial and training restrictions along with the required military standardization model, that range agility is assumed to be low. This analysis provides for any WAN optimization software that will have a good fit overall, keeping in mind not overspending to improve time agility.

3. Business Integration Versus Business Standardization

The task idiosyncrasies of the USMC mission require high business process integration with high standardization in order to meet the requirements of the global nature of the mission and the military standardization of processes with global data access.

WAN optimization software, such as Cascade, has adopted an integrated behavior providing the ability to drill down into network data to determine the source of any performance bottlenecks. It also can provide a full graphical representation of server, application, and user dependencies, so current application delivery problems can be resolved and future IT investments planned. In addition, these types of services provide the ability to create, maintain and enrich a library of cases that can be used in the future for finding problem solutions according to the Case Based Reasoning (CBR) model of network monitoring and repairing.

WAN optimization software systems automatically learn which events happen on a daily or weekly basis. Due to agentless characteristics, WAN optimization software like Cascade can be a nonintrusive remove hyphen before all prefix *non* solution that does not require any physical probes in branch offices, providing an easy, cost-effective way to monitor a wide variety of applications.

Once a key application metric goes outside the normal range, WAN optimization software like Cascade can send out an alert. An administrator can then troubleshoot the problem by drilling down into the network information. These business-centric views allow for easy navigation from interfaces to applications, servers, and users.

4. Agility

One may assume that WAN optimization companies provide applications with time agility orientation. However, a deeper analysis of their specifications and configuration details provide evidence that they address the agility challenges by covering a wide range of combinations and compatibilities with a number of

Data Flow Sources (like NetFlow, IPFIX, sFlow, etc.) In addition, they offer a selection of product series according to data capacity requirements that enhance the assumption of their range agility orientation.

5. Service Oriented Architecture (SOA)

Thinking in terms of services, business function can be constructed so that it stands on its own. This approach (SOA) takes into consideration the needs of both providers and users, where the provider offers functionality in the form of interfaces to the service capabilities they are providing, and the users then access those capabilities.

6. Functional Management Model

The network management architecture that WAN optimization software uses is the functional management model that consists of five functional areas:

- Fault
- Configuration
- Accounting
- Performance
- Security

This model provides more functional granularity to the architecture.

7. Key Benefits for Cascade

An ROI study of Cascade customers, conducted by IDC in 2010 on behalf of Riverbed, found a three-year ROI of 364% and a payback period of 5.5 months. The study uncovered benefits in several areas:

- Improvements in IT staff productivity.
- Cost reduction.
- An increase in user productivity due to less downtime, resulting in significant annual benefits per one hundred users.

- Average duration of help desk calls was reduced by 87% because the help desk staff more easily identified the source of problems and estimated the resolution time.
- Significant annual savings on server and tools purchases.
- Thirty-four percent fewer downtime incidents per month; the average incident duration cut by 51%.

Despite these findings and other research, this thesis seeks to challenge these assertions from an applied science and knowledge value perspective.

B. PREVIOUS WORK

This thesis follows on research that began with Shane Jenson. Shane Jenson wrote a thesis in 2009 entitled *Consolidated Tactical Network Analysis for Optimizing Bandwidth: Marine Corps Support Wide Area Network (SWAN) and TCP Accelerators*. His work included a portfolio comparison of four TCP accelerator systems (TurboIP-G2, Cisco Wide Area Application Services [WAAS], Citrix's WAN Scaler edition, and Cascade by Riverbed Technology) against the current TurboIP device. Jenson's work was primarily technical as he sought to determine which product performed the best. His research ultimately chose Cascade along with its Riverbed Product line as the best performer among the selected competition. This thesis is meant to take these findings to the next level in a cost-benefit analysis.

C. THESIS ORGANIZATION

This thesis is organized to introduce the current climate and practices in the DoD, the recent supporting research concerning the various aspects of the problem, and an analysis that demonstrates the power of this new approach. At the time of this writing, the DoD needs to evolve now to prepare for future budget cuts, which are inevitable. The IT efforts within the DoD have been the least beneficial in terms of ROI and none of the programs has ever been cut, even when they have been determined to be ineffective.

The supporting research addresses the most recent peer reviewed documentation for software adoption procedures, business process reengineering, and knowledge value

added analysis. Each of these areas is examined with the DoD as the central theme incorporating the directives and orders governing these procedures. This level of support is sufficient to lay the necessary foundation for the research in this paper.

The last section carefully applies the supporting documentation to a real-world IT solution. WAN optimization is found to do more than simply increase bandwidth—it also provides an opportunity to reengineer the process. This analysis is the final step necessary to progress into full implementation.

II. LITERATURE REVIEW

A. INFORMATION TECHNOLOGY INFRASTRUCTURE LIBRARY

The Information Technology Infrastructure Library (ITIL) comprises the best practices and standards for IT services and operations. ITIL addresses the framework for IT management in broad general principles that are applicable to all organizations both large and small. This scalable approach, with applied heuristics, gives good direction to managers on how best to employ IT solutions in their organizations; however, there is one dangerous omission that must be considered before blindly implementing these principles. This paper will examine the great ideas of Service Support and Information Communication Technology (ICT) Infrastructure Management in relation to the associated danger of holistic implementation that must be understood prior to adoption.

1. Significant Concepts of Value

The ITIL overview article suggests that, “Service support describes the processes associated with the day-to-day support and maintenance activities associated with the provision of IT services” (Bryant University, 2006). These service support guidelines identify the framework for providing services to the end user as the primary focus of the organization. The uninterrupted flow of information sustains the network activity and facilitates the operations and business processes. The measure of effective performance on the network is the level of quality by which this information is available and the ability to support the end user.

The function of the help desk is to be the central focal point for handling incidents, problems, and change services for the network users. The help desk’s ability to optimize the network is essential to service support. In the area of WAN optimization, the technicians depend upon software to quickly adapt to the rapidly changing demands of the users on the network. WAN optimization software can provide service support based on the behavioral baseline for user activity, react to variations, and report maintenance requirements prior to notification. Figure 1 demonstrates the role that the service desk plays as the conduit between the customers and the numerous services it manages.

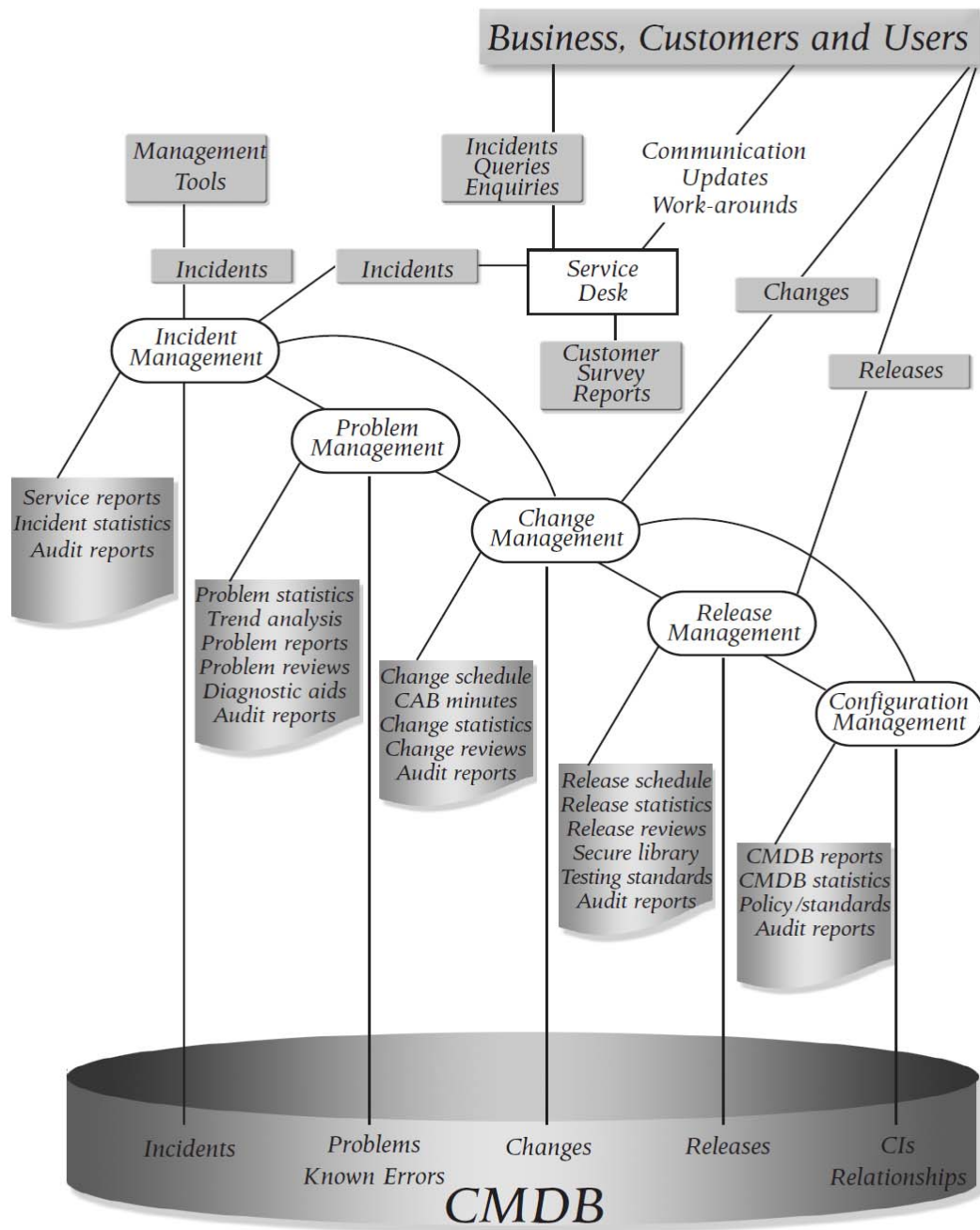


Figure 1. Service Support (From Rudd, 2004)

2. Benefits

One benefit of service support guidelines lies within its management modules. These management connections work to tie the IT functionality and services to the business processes of the organizations. The IT problems in the organization can only be rectified through tailoring a solution to the process or through reengineering the processes of the organizations. The alignment of IT services with the current and future needs of the business helps to carry out the intent of the overall strategy (The Benefits of ITIL, 2004).

In addition, the service support guidelines are to provide the best practices for reducing the cost of providing IT services. Minimizing the disruption of service through problem management of the help desk results in a quantifiable cost saving. For example, the adoption of problem management reduces the number of help desk incidents by 500 (10% of total) per year. This returns a savings of $\$500 * \$50 * 10/60 = \$4,000$ per year (The Benefits of ITIL, 2004).

3. Failure to Implement

Failure to not adopting the service support guidelines will result in diminished application quality. The applications are directly tied into the business processes, which include data sharing and all other user functions. Having an effective system to manage incidents, handle problems, resolve interruptions, and make configuration changes will assist in optimizing the network. A network functioning at optimal levels will ultimately reduce operational costs in delivering valuable information to the users when they need it most.

4. Concept 2

Information and Communication Technology Infrastructure Management (ICT IM) covers all aspects the best practices for identification of business requirements through the tendering process, to the testing, installation, deployment, and ongoing operation and optimization of the ICT components and IT services. (Bryant University, 2006)

The ICT Infrastructure Management is primarily responsible to provide the infrastructure for service support. The framework for these guidelines includes the entire

spectrum of ICT from design and planning and technical support to deployment and operations. Figure 2 demonstrates how these guidelines align the policies on the business level with the ICT policies, design and architecture, and program and project plans. This coordination is used to determine the best components as the platform to support the services.

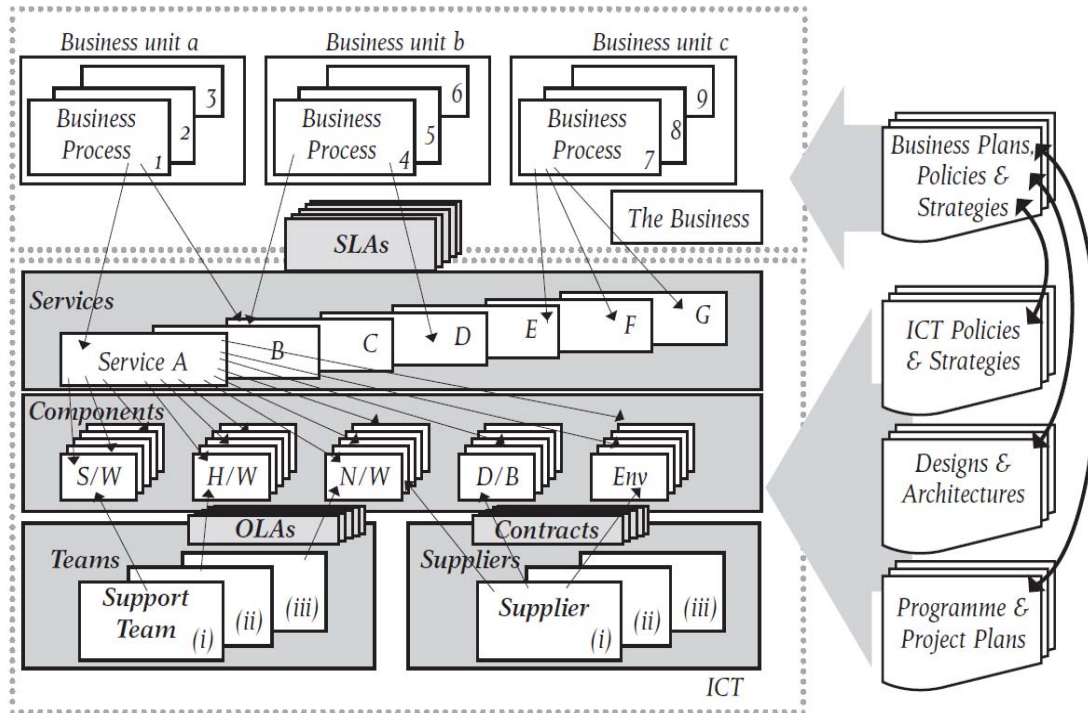


Figure 2. ICT Infrastructure Model (From Rudd, 2004)

5. Benefits

The provision to allow a business to adapt to a rapidly changing environment is a tremendous benefit in any organization. The ICTIM practices facilitate the transition process by providing a vehicle to deploy new processes while maintaining backward compatibility until new projects are available. Minimal disruption in services results in a significant savings since users are not negatively affected. These savings can be calculated in the downtime that would normally hinder user operations.

The benefit of the technical support structure is that this best practice controls the dissemination of the support services. Support can be provided through an asynchronous

or synchronous message delivery platform. This provides a competitive advantage as techniques are drawn from an in-depth pool of knowledge ready to respond with IT solutions. This state of a full storage of support gives meaningful support through the ICT Infrastructure. For example, if the help desk has the ability to monitor the network continuously, while anticipating user demand, poor performance can be rectified before notification. This type of service preempts harmful effects in the distribution of information.

6. Failure to Implement

Failure to implement ICTIM best practice techniques could severely degrade architectural qualities as they relate to the sound structure of the architecture. The goodness of the architecture is judged in relation of how well it responds to the organization's needs. Failure to incorporate these architectural qualities also ignores conceptual integrity that involves the strategy or vision, combining the design of the system, at all levels. Foregoing the practices that foster correctness, completeness and build-ability undermines the organization's ability to provide valuable services at the right time.

7. Dangerous and Omitted Concept

Taking a holistic approach to implementing the ITIL best practices can be time consuming and a potentially costly approach to using these guidelines. Rudd admits that there is no universal solution for optimized processes as well as a need for the adoption and adaptation for every organization that accepts these standards. Furthermore, the ITIL has good principles in their individual modules; however, the consistent theme throughout the ITIL best practices involves the integration in all areas with all business processes. Most organizations have interdependency between processes and the IT that support them. Consider the Department of Defense (DoD), which has a wide variety of services that trickle down through a hierarchy of systems including commercial vendors. To bring all of these systems into concert with one another cannot be done all at once

without significant work stoppage. A holistic implementation would disrupt the operations in order to facilitate the new standards and infrastructure construction outlined in ITIL.

The solution proposed by this thesis for ITIL implementation would be a step-by-step approach in order to minimize the change impact on the organization and the resistant staff. Consider the following approach to tailoring these best practices for optimal IT solutions: conduct a preliminary study for feasibility, maintain awareness for workability, plan for change, implement it, and continue to manage the life-cycle aspects. This is similar to the DoD acquisition program and could easily be incorporated along with other projects. No matter how ITIL is implemented, a step-by-step approach would be highly adaptable and allow the organization flexibility during the implementation process while reducing costs due to interruptions.

B. SOFTWARE EVALUATION PROCESS

The current software evaluation process is very similar to the acquisition process for weapons systems or any other major end item development in the DoD. The process begins with an extreme focus on user requirements and an evaluation of technological resources prior to making the Material Development Decision (MDA) (DoDI 5000.02, 2008). These user requirements are communicated through the analysis of use cases to identify the functions for the system as they interact with the various users in the business process. This is strictly a linear process to provide the foundation in developing the software. Unfortunately, even though there is an enormous amount of due diligence taken at each step of the evaluation process to ensure requirements are being met, there remains a deficit in understanding whether or not the return on investment is worth moving forward. Figure 3 demonstrates the current process with numerous steps mandated prior to full implementation.

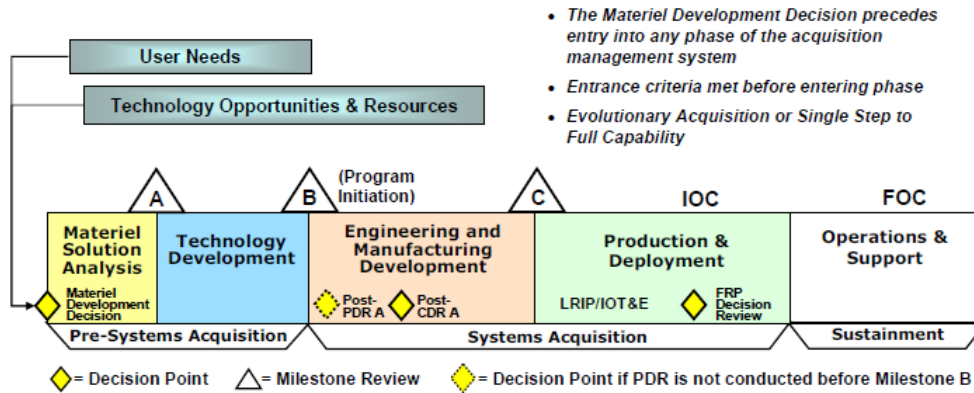


Figure 3. The Defense Acquisition Management System (From DoDI 5000.02, 2008)

The sum total of the user's needs should be directly correlated to the available resources and technology on the market. There are few areas where DoD can afford to customize IT solutions and properly maintain it throughout its life cycle. Therefore, the evolutionary acquisition is the most useful suggestion in the DoDI 5000.2. Evolutionary, in this sense, refers to the ability to incrementally adapt to an ever-changing environment. This approach not only provides a service to the warfighter as quickly as possible, but it also facilitates the use of commercial off-the-shelf (COTS) equipment.

Figure 4 demonstrates the initial input of user requirements there needs to be a one-to-one comparison to identify the software architecture that fulfils the requirement, followed by a conceptual marrying between these ideas with COTS products.

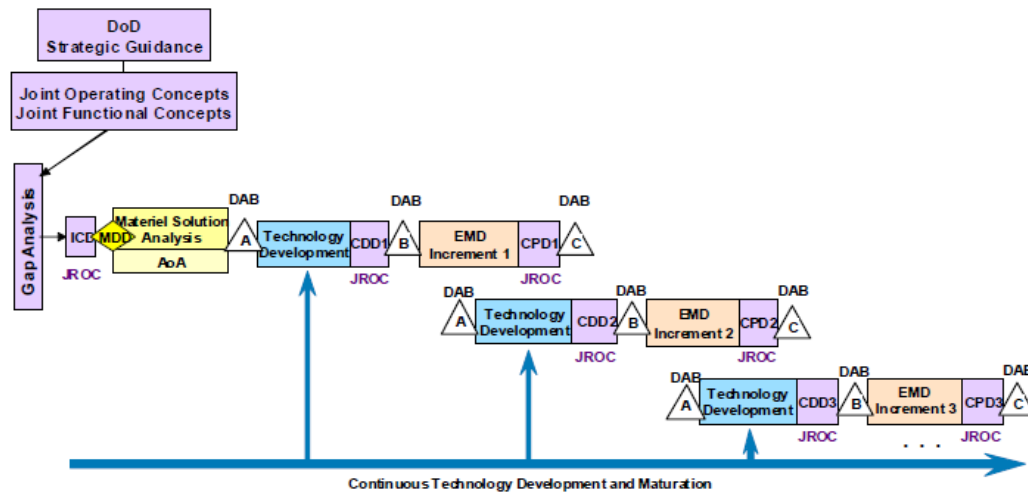


Figure 4. Requirements and Acquisition Process Flow (From DoDI 5000.02, 2008)

This type of analysis is evolutionary as it responds quickly to user needs while using an IT solution that has already proven to be successful. This also helps to fulfill the directive's mandate, which states that the DoD should focus on joint concepts when implementing these major IT programs. Joint efforts are more likely to be supportable by COTS products rather than the customized systems feeding numerous interfaces. The overall advantage can be realized through the product line architectures (PLA) that already exist throughout these commercial entities. These PLAs consist of the bundling of products by a manufacturer and can easily be adaptable to an ever-changing environment.

The Material Solution phase reviews the various solutions and makes recommendations as to which one is the best option. MDA approval does not mark the genesis of the program, but rather confirms that enough information has been presented for further evaluation. An Analysis of Alternatives (AoA) must be reviewed to determine whether there are any other options available. This would be an optimal point to review the IT solutions for their impact on the business process, as well as the expected return on investment.

The next step in the DoD's software evaluation process is the Technology Development phase. This is where all of the previous documents and findings are being reviewed to validate continuation of the process. This provides the framework for conducting Milestone A, which essentially is the beginning of the program. All cost estimates are evaluated but no directive is given to access the benefits of moving forward with this project. There needs to be a metric by which the stakeholders can evaluate the "go/no go criteria." Going forward with any IT program needs to be supported by its workability within the current or reengineered process. These decisions must be made as soon as possible as to determine the effect of the automation on the user and the advantages gained by implementing the program. This combination of process and a return on investment metric is the main shortcoming in the DoD software evaluation process, which will be discussed in detail later in this thesis.

The Engineering and Manufacturing Development (EMD) phase is the culmination of all of the research to this point (DoDI 5000.02, 2008). The user's needs through the AoA are comprised to give the design engineers the best picture for the IT solution. It also takes into consideration the key performance parameters (KPP) stated in the requirements by the user. These KPPs address the quality attribute of performance; in this case it is the manner in which the IT solution has to perform to be considered a viable solution. For example, if the solution has to be available around the clock then some sort of asynchronous platform has to be designed. If the system is synchronous and has to wait for a response before moving on, then this may not work for the user. The KPPs have to be adhered to in this design phase. According to Gorton, it becomes an iterative process at this stage to ensure KPPs are met.

The EMD phase includes Milestone B, which is essentially the beginning of the program. At this point, costs begin to rise exponentially, so it is paramount that all due diligence has been taken up to this point to ensure some level of success. EMD has two major efforts: Integrated System Design, and System Capability and Manufacturing Process Demonstration (DoDI 5000.02, 2008). Gorton suggests some basic software architectures, which are proven universal roadmaps to support these efforts, and two

successful approaches to testing the design. Both of these areas must be satisfied before entering low rate initial production (LRIP) and transitioning into full rate production (FRP) (DoDI 5000.02, 2008).

[Software architecture goes] beyond the algorithms and data structures of the computation; designing and specifying the overall system structure emerges as a new kind of problem. Structural issues include gross organization and global control structure; protocols for communication, synchronization, and data access; assignment of functionality to design elements; physical distribution; composition of design elements; scaling and performance; and selection among design alternatives. (Garlan & Shaw; Eden & Kazman, 2003)

Gorton suggests that using basic software architectures for the design produce the following benefits:

1. Can use existing successful frameworks—no guessing, no new construction
2. Helps to align design with quality attributes
3. Provides the technology platform to support development
4. Reduces system complexity.

Each of these benefits has a cost associated with it. There is a cost to implement and a realized cost if not implemented resulting in project delays and an unsatisfactory failed design. The building of the framework is the primary benefit since other aspects can be customized. This is also a proven architecture, and therefore DoD can expect success in this area as well. The alignment of the design to the quality attributes helps to fulfill the KPP requirement. As further assessment of the user's needs is accomplished, the KPP are solidified with a plan for implementation. As mentioned before, the life cycle of the system must be examined before these designs are adopted. Flexibility must be adhered to, since technology is rapidly changing along with the user's needs. Finally, any system that is going to be evolutionary must reduce its level of complexity. Using components that are interchangeable allows the DoD to quickly react in its unique joint environment.

Failure to implement Gorton's software architecture suggestions could result in the following failures:

- 1 Increase failure rates in software projects
- 2 Eliminate the ability to predict and mitigate risks
- 3 Prohibit the ability to determine staffing needs.

Designing software architecture from scratch is very unpopular because this level of complexity lends to making mistakes throughout the software program. Furthermore, at this phase of production, the DoD must take incremental steps and proven techniques to lower risks. A case study full of history on Gorton's suggestions exists. The author recommends that those work best when creating new IT solutions. Finally, determining the impact of the automation needs to be understood. The use of these known software architectures yields a great segue into how the staff may change or how the process may be reengineered with fewer people or less equipment. These aspects contribute to the return on investment associated with the IT solution and can be quantified in a properly validated architecture.

1. Architecture Validation Process

The architecture validation process is an essential ingredient to ensuring the design has been properly engineered to meet user requirements. It is part of the LRIP stage that will provide the test results for FRP. The two testing methods are scenario manual testing and prototyping (Gorton, 2006). Scenario testing is a step-by-step progression through the design pattern. It compartmentalizes each step and determines its impact on the next step until the scenario is complete. Consider Gorton's simple design of a purchase shown in Figure 5.

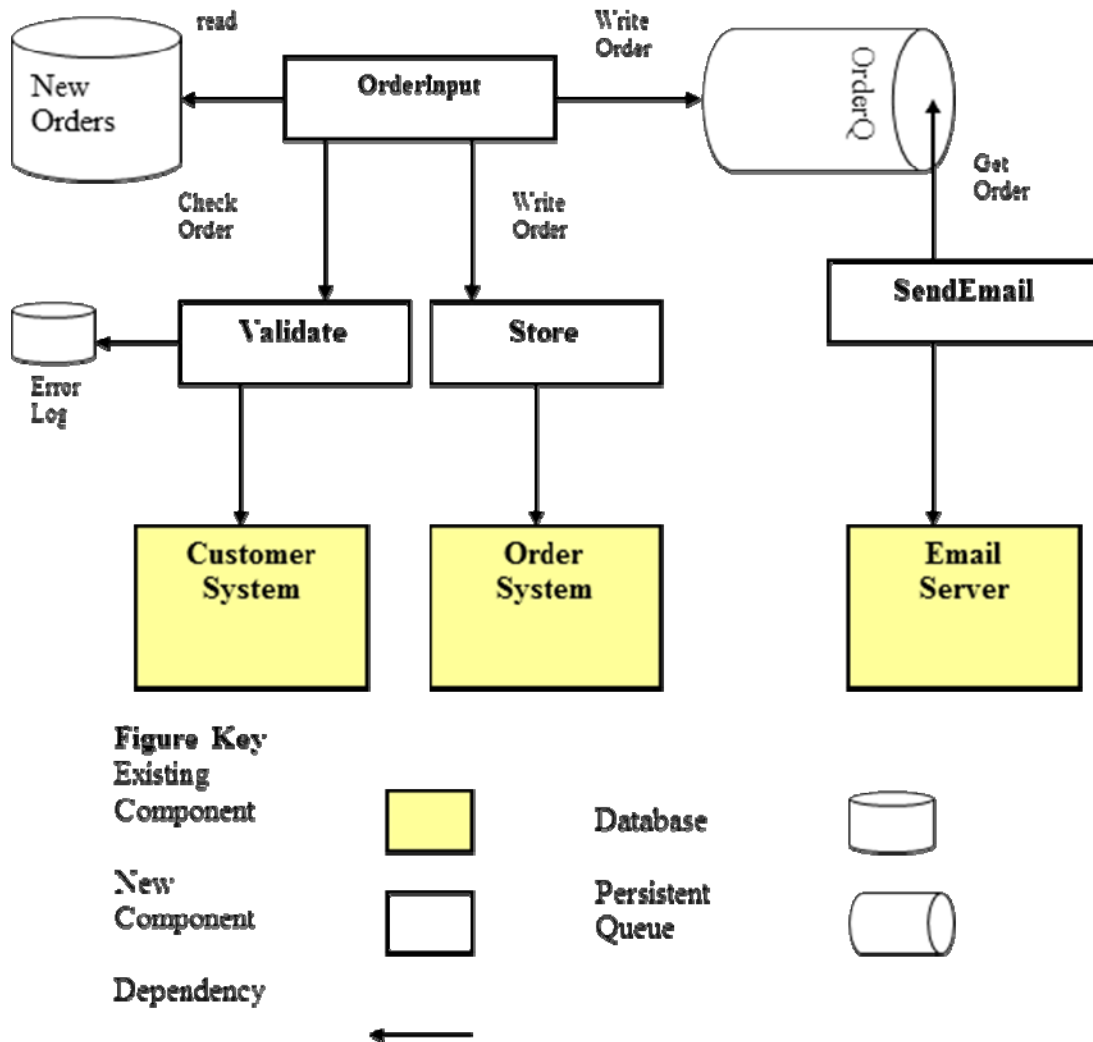


Figure 5. Gorton's Design of a Purchase (From Gorton, 2006)

Each step of this design demonstrates the inputs and outputs, bottlenecks, queue status, and the final impact on the customer, order and email systems. The engineer can walk through each step to gain an understanding of how the software architecture will perform. The engineer will also gain an understanding about the quality attributes associated with the KPPs. Table 1 demonstrates how the architect can identify the desired quality attributes and determine whether the response is adequately fulfills the user's needs in the scenario (Gorton, 2006).

Quality Attribute	Stimulus	Response
Modifiability	The <i>Customer System</i> packaged application is updated to an Oracle database.	The <i>Validate</i> component must be rewritten to interface to the Oracle system.
Availability	The email server fails.	Messages build up in the <i>OrderQ</i> until the email server restarts. Messages are then sent by the <i>SendEmail</i> component to remove the backlog. Order processing is not affected.
<i>Reliability</i>	<i>The Customer or Order systems are unavailable.</i>	<i>If either fails, order processing halts and alerts are sent to system administrators so that the problem can be fixed.</i>

Table 1. Scenario Testing (From Gorton, 2006)

At the end of this test, the engineer can determine if the response is acceptable for the user. The design change needs to take place at this point if the results are unsatisfactory. Unfortunately, every evaluation cannot be accomplished through scenario testing. The more unusual or unique requirements must be demonstrated in a prototype.

Prototype testing may yield the best confirmation of successful software architecture, but it can also be the most costly. Making these small replicas requires a minimal structure that has the same scalable performance as the required end item. For example, if the prototype is built using a 1:5 ratio, then it must be able to produce 20% of the proposed workload. This stress regression gives the technician confidence in the final product that fully addresses the user's needs.

2. COTS Software Evaluation Process

The DoD seems to be lagging behind the private sector in the area of evaluating and selecting software (Commella-Dorda et al., 2004). While there are similarities, there are a few where the DoD could change its process to gain a competitive advantage. In comparison, the DoD and the private sector both concentrate on stringent requirement analysis. This provides the basis to support the software venture. However, the private sector tends to view these user requirements in both current and future states or environments, which allows those organizations to act in a more evolutionary manner, dynamically changing in accordance with the needs of the organization and availability of new technology. The DoD directive strategy promotes the use of COTS products but, in the author's opinion, this approach is rarely pursued due to bureaucracy and overall complexity. In sharp contrast to the DoD's position, the research at the Software Engineering Institute (SEI) Carnegie Mellon University suggests that the software evaluation process be facilitated primarily through the use of COTS products (Commella-Dorda et al., 2004). This approach emphasizes the criteria every bit as much as the requirements demanded by the users.

The authors of this SEI technical report suggest that COTS software evaluation has the benefits and limited risk that the DoD's directives are mandating (Commella-Dorda et al., 2004). Benefits such as the potential of rapid delivery to end users, shared development costs with other customers, and the opportunity to expand capacity and performance as improvements are made in these products (Commella-Dorda et al., 2004). Once the basic planning has been determined, such as forming the team, the main focus of the evaluation is assembled around the evaluation technique and the criteria.

The step-by-step approach to evaluating COTS software involves an evaluation at every step of the process. The entire team is comprised of experts examining the software for different issues. For example, the accountant is reviewing the costs over the life cycle while the engineer, architect, and other technical professionals ensure the design meets the user's requirements. These are not autonomous activities. The impact of any change in design can ripple through the project with many unintended consequences. Therefore, it is paramount that there is a quality process in place to gain the most benefit from the evaluation.

There is a long history of software adoptions ending in disaster simply because a quality evaluation process was not implemented (Commella-Dorda et al., 2004). According to SEI, the following mistakes were the culprit in most of those failing programs. However, this technical report provides recommendations to avoid these types of mistakes in the DoD.

Mistakes	Description
Inadequate level of effort	Informal Internet search.
"Once and done"	New products without reevaluation
Non-contextual	Consumer reports used alone
Limited stakeholder involvement	Engineer selection without user input
No hands-on experimentation	Marketing data used accepted as fact

Table 2. Common Mistakes Causing Failure in Programs
(From Commella-Dorda et al., 2004)

PECA is the acronym for the COTS software evaluation process. It stands for plan the evaluation, establish criteria, collect data, and analyze results. Planning, as mentioned before, outlines the technique to use: the team, the stakeholders, and the charter that describes the conduct of the process. Establishing the criteria is much more challenging as it describes the metrics that are to be used to determine whether the project is

successful. The criteria will also be beneficial in determining a confidence interval or acceptable range of benefits. This is the most important step since collecting and analyzing the data are the last two steps. The criteria must be both measureable and quantifiable to identify the determinants that result in a successful software solution.

Each criterion may be based upon the user requirements; however, the other aforementioned attributes must be determined during the evaluation process. This approach further clarifies the need and provides an answer to the various gaps. This also exceeds determining the KPPs alone, but rather takes a more holistic view considering interdependent aspects. Table 3 is an example of a good criteria report.

Requirement	The COTS vendor will provide support
Capability Statement	Support includes: -24x7 help desk -onsite installation -online error reporting
Measurement Method	A product support survey will be provided to potential COTS vendors. Support claims will be verified by exercising help facilities where possible and by contacting current product users to determine the quality of vendor support.

Table 3. Example of Good Criteria

The relevance to the DoD lies within the ability to transform the user requirements into this level of detail. The more information that can be extrapolated during the software evaluation process the better understanding can be gain to determine the workability of the COTS products.

C. BUSINESS PROCESS REENGINEERING

The difference between a process and a function has become increasingly important to define the cross-functional operations of an organization (Cook, 2010a). Functions are stovepipe lanes that can be bundled by the use of processes to accomplish a variety of tasks. In addition, processes can provide the metric necessary to streamline or optimize operations while realizing the return on investment through reengineered efforts. This section will use this connotation as the basis for business process reengineering.

The business process is not linear, but rather a transition through functions in a series in a non-sequential manner. This makes it difficult to identify the length of time or bottlenecks associated with the entire process. Consider the supplier to customer diagrams below. Figure 6 represents a linear delivery function that traverses incrementally through the system.

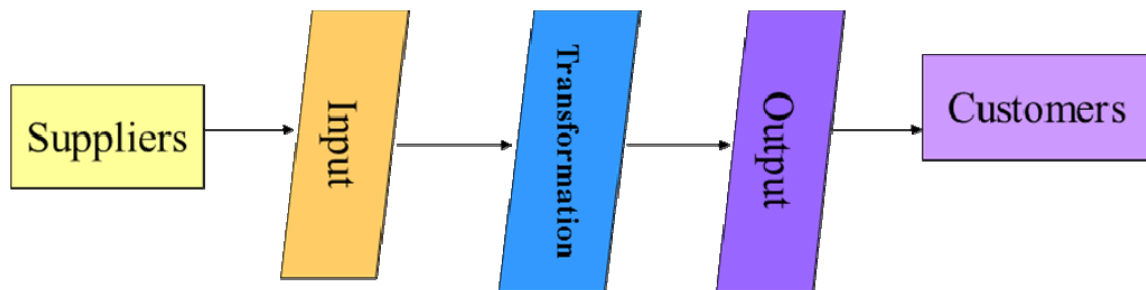


Figure 6. Linear Delivery Function (From Cook, 2010a)

In contrast, Figure 7 introduces the complexities that actually exist in an environment with numerous suppliers and customers. Each example has the same basic features but more options are available to take advantage of in the process. As the

organization mixes and matches the components or reengineers the process, the goal is to produce a better outcome through less time or with the use of fewer resources. These are the quantifiable measurements managers need to determine the return on investment.

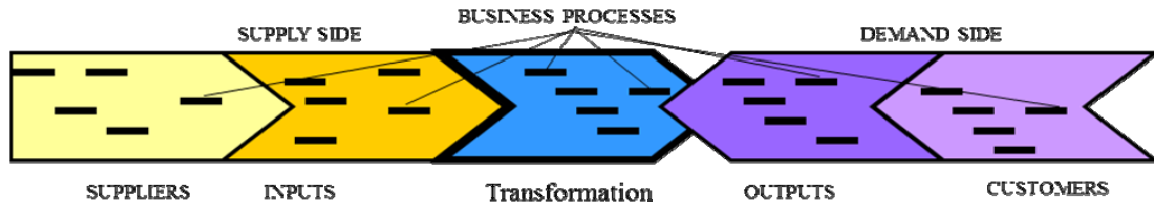


Figure 7. Process Transformation Model (From Cook, 2010a)

1. Potential Impact

Results of IT solutions have been widely varied among organizations and it has been increasingly difficult to understand the level of productivity it produces (Sobhani & Beheshti, 2010). The integration of investments in IT and other activities within the organization should be coordinated to reengineer the business process to realize more benefits (Sobhani & Beheshti, 2010). According to Sobhani and Beheshti (2010), “The association of IT and Business Process Reengineering constitutes opportunities to demonstrate the impact of IT investment on productivity.” Furthermore, the people or human capital dimensions of an organization deal with issues such as learning time, educational activity, grooming, overall motive, and reward systems. The concept of business processes make up the activities aimed at creating and delivering a value-added end product to the customers. The most impactful processes mirror numerous attributes such as process ownership, customer-centered, value adding, and cross functionality. The bottom line is that the IT solution provides the means to accomplish new business processes that would otherwise be impossible with the current level of resources.

2. Process Focus Versus Functional Focus

The functional focus is oriented towards the inward workings of the organization to accomplish an intended goal (Cook, 2010a). The functions include such areas as marketing or finance, stovepipe structures that accomplish a defined purpose. In contrast,

processes are matrix type structures that cut across the functions to accomplish a unique purpose. The process provides a span of control in the organization that is nonexistent with functional areas alone. As a result, a process is most effective when its measured output fulfills the purpose for which it was created and its full capabilities are realized through the overall logical expectations of the actors (Housel & Bell, 2001).

3. Benefits of BPR Implementation

It is necessary to understand the carrying out process of BPR in order to be aware of the benefits of BPR (Yin, 2010). Yin suggests considering a 3X3 process reengineering. An analysis of the carrying out of these demonstrations identifies the sort of benefits that can be brought to the organization from each phase. Figure 8 demonstrates the 3X3 principle of process reengineering with three separate phases. In the initiation phase, the important business concerns and processes are identified and thoroughly scrutinized for their improvement potential (Yin, 2010). The acquisition and procurement process of prototype parts is referenced in this phase as a critical process in the development. This will aid in directing the organization towards process-centered thinking in the future. In the definition phase, the team, through consensus, identifies the root causes of the problems and defines appropriate measures that can lead to solutions. The team also identifies the structure that will change the behavior and facilitate the adaptation of the new process. As a result, the new process shows early benefits as the new organization becomes more flexible and efficient than the former one. The focus on core business processes is one of the main benefits that BPR brings to the organization (Glykas & Valiris, 1999). If the organization applies IT to simplify the complex work and obtains dramatic improvement, a powerful network environment can result by which the company increases its competitive advantage. Finally, in the control phase, it is imperative that buy in is assumed by the employees to forge through the transition, to use the new procedures in order to continue improvement, and to ultimately gain success in the new process. Figure 8 displays these concepts.

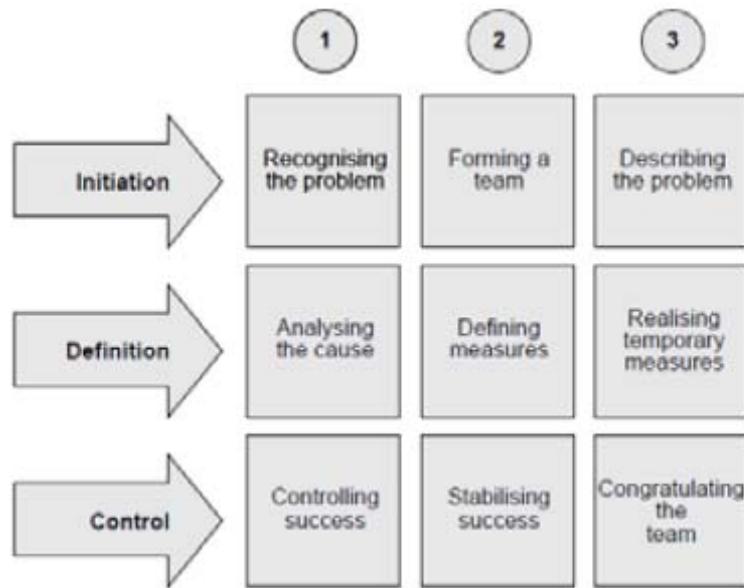


Figure 8. 3X3 Principle of Process Reengineering (From Baumgartner, Walliser & Zinser, 1998, p. 157)

Yin identifies the benefits that the organization may obtain through successful BPR implementation:

1. Employee awareness for the need of continuous improvement
2. Continuous fundamental rethinking
3. Guarantee that the BPR philosophy will continue to flourish in the organization
4. Proper communication, coordination and control established in the organization (Glykas & Valiris, 1999). Once BPR is successfully implemented, the organization will reap at least one of the following benefits:
 1. Productivity, decreased cycle time, inventory or cost
 2. Profitability, increased economic growth
 3. Quality, improved products or services and related information (O'Neill & Sohal, 1998).

Yin demonstrates his implementation principles in a notional case study that presents the existing process and then the reengineered version. The goal of the BPR effort is to shorten the ordering process from nine days to one. The preliminary investigation revealed the following problems.

Figure 9 diagrams Peppard and Rowland's (1995) conclusions that non-value-adding activities should be eliminated, the remaining process should be simplified, the simplified tasks should be integrated, and basically sound process should be automated when implementing BPR (it is also called ESIA method). Based on the above theories, the obvious problems in the cases that affect efficiency lie in the following aspects:

- a) Involved units work separate. It takes a long time to deliver information from department to department or person to person.
- b) Reformatting the order waste time. The order needs to be rewritten when it passes from sales department to marketing department. It is the duplication job that needs to be eliminated.
- c) Credit check requires three to four days by an outside agency. It is a big problem in this case, as the goal of order process is now only one day. Another problem is that the credit check should happen before the Client Group assigns the order number, because the company will not supply the container to customers if they have bad credit.
- d) In the Engineering Department, a simple job was divided into two parts and each part was responsible by different people. The Production Controller has to rework and get relevant information from Supervisor. The rework job is a kind of waste that needs to be removed and the simple jobs need to be integrated.
- e) In the current process, information is delivered by paperwork. It ties up the armies of bureaucrats yet contributes little to the main job. It could also be eliminated by utilizing IT.

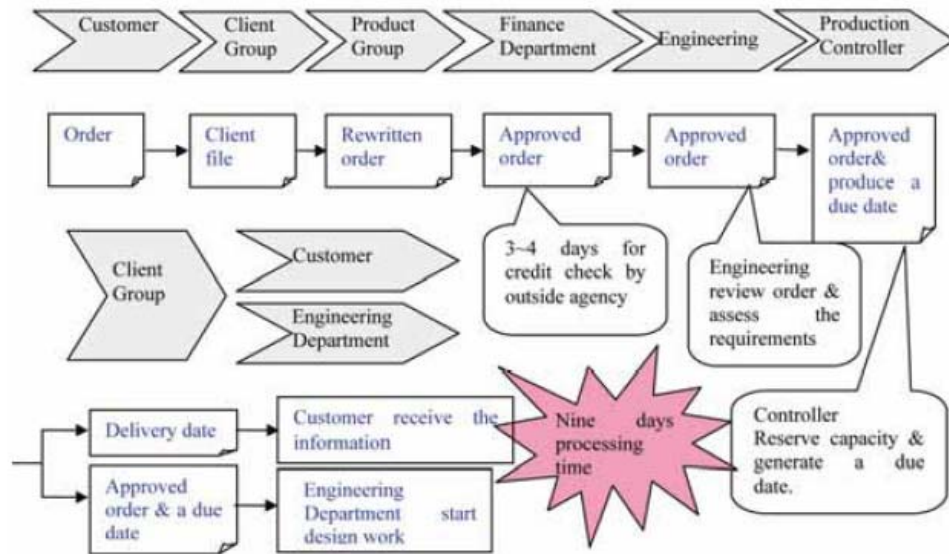


Figure 9. Flow Diagram of Existing Process (From Yin, 2010)

Yin's findings, diagram, and new process interpretation follows:

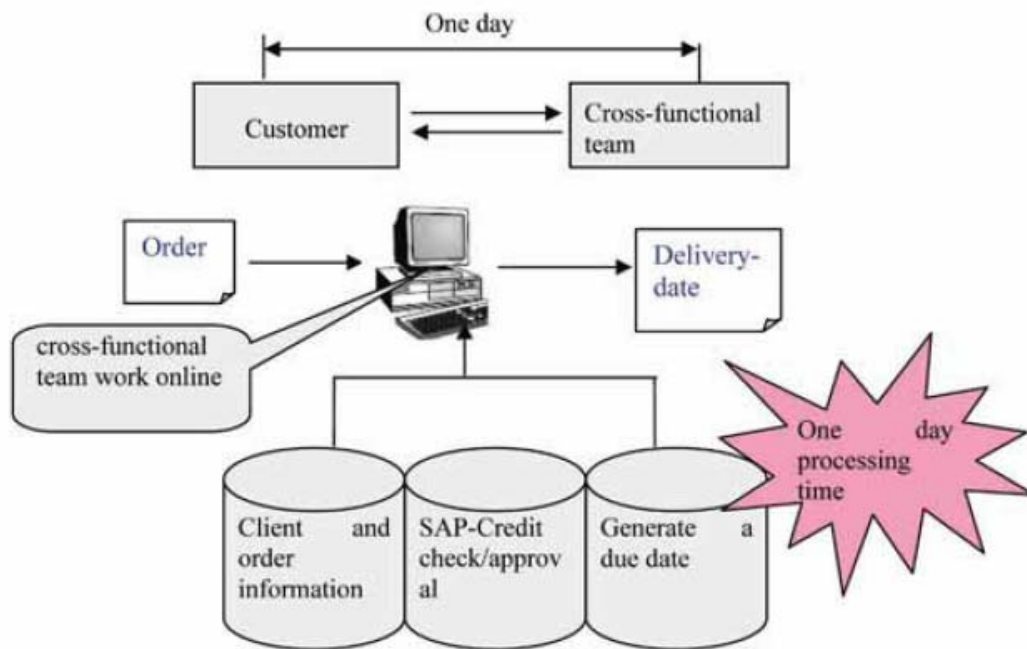


Figure 10. Yin's Diagram (From Yin, 2010)

The new process can be interpreted: The employee from sales who belongs to cross-functional team receives the order via mail, fax or telephone, then, put the client and order information into a certain database in company terms, and the client credit check is completed at the same time. If there is no problem with the credit check, the information will keep in “need to deal with” database. The computer will alarm the next responder who comes from engineering department. All numbers in this cross-functional team can access this database at any time. If finance wants to get information, they can log in this database; same as marketing. The employees who come from the engineering department get information immediately only when the client was passed the credit check. They estimate the work content immediately based on the information, and reserve the required machines online and then add the due date into the file. When the job of generating due date was finished, the computer system would alarm the person who creates the information. The team member from sales get the due date information online immediately, and sends a fax to the customer who orders the container. The whole order processing process can be completed in one day. IT plays a key role to ensure the success of BPR implementation in this case (Yin, 2010).

4. Integration of BPR and Lean Six Sigma

Combining Lean Six Sigma with basic BPR principles results in a customer focused view of problem identification within a company. Six Sigma’s problem solving ability within a BPR effort can help an organization address its problems by delineating necessary from unnecessary functions or IT alternatives (Carey, 2010). At the core of Six Sigma is the foundational principle that business processes are dynamically unpredictable. They are directly correlated to both the human and market forces that they seek to transform it. Lean Six Sigma provides a way of measuring the variability in a process as it delivers services to an end user or customer. When managers refer to Six Sigma, they are indirectly referring to BPR methodology. This method is introduced for making the necessary changes to an existing process when it is no longer meeting the customer’s needs (Carey, 2010). Since BPR addresses a radical redesign and wiping the slate clean, the BPR approach would, from a purist’s standpoint, align more with the Design for Six Sigma (DFSS) than any other. DFSS is often used to design a new process

through redesigning an existing one from the bare skeleton of the process to better meet customer needs while reducing variance in productivity as much as possible (Carey, 2010).

D. OVERVIEW OF KNOWLEDGE VALUE ADDED

Knowledge has numerous meanings throughout a wide array of disciplines in academia. From a state of consciousness in philosophy, to the all-important experiences or lessons learned in the business world, knowledge is valued as a supporting metric for decision makers. According to Housel and Bell (2001), knowledge is simply “the know-how needed to produce process outputs.” He goes on to illustrate KVA as an average person possessing all of the company’s know-how to transform inputs to produce necessary outputs. In addition, human capital sources, which store this knowledge, can be quantified by their productivity to calculate a return on investment.

Knowledge has numerous meanings throughout a wide array of disciplines in academia. From a state of consciousness in philosophy to the all important experiences or lessons learned in the business world, knowledge is valued as a supporting metric for decision makers. According to Dr. Housel, knowledge is simply “the know-how needed to produce process outputs.” He goes on to illustrate KVA as an average person possessing all of the company’s know-how to transform inputs to produce necessary outputs. In addition, human capital sources, which store this knowledge, can be quantified by its productivity to calculate a return on investment. It is this capability that is now being substituted by IT solutions that will be analyzed for their contribution towards the business process. This form of analysis is directed by the DoD but no formal evaluation exists to obtain this information.

1. Return on Investment Directive

Department of Defense Directive 8115.01 mandates that all IT investments be managed as portfolios. Portfolios relate to the management all of the systems within an enterprise. This holistic approach designates that all systems pertaining to an enterprise must all be contributing to the combat readiness of the warfighter while eliminating those

non-productive systems. To achieve this analysis, the portfolio manager must evaluate all IT systems in the areas of analysis, selection, control, and evaluation.

The analysis phase is a comprehensive review where the strategic objectives of the enterprise are assessed on how well they accomplish the vision and mission of the organization. The level of production is measured to decide whether or not an IT venture is worth the investment. These metrics represent a quantifiable outcome at this stage, which identifies whether the desired outcome is met along with the acceptable cost and risk associated with it.

The selection phase attempts to assemble the best collaborative mix of systems, architecture, and components to support the enterprise. Selection will identify the best market solutions available while establishing alternative options. It also conducts a final evaluation of the cost before major purchases are finalized.

The control phase is directed to ensure continued quality oversight is applied to IT investments. The control manager must enforce modifications as quantitative measures fall below acceptable levels. This will provide guidance for continuing this IT investment while ensuring minimal resources are allocated to a poor performing portfolio.

The final recommended phase is the evaluation. The purpose of the evaluation is to determine whether or not the outcome has a measureable improvement over the current outcome. This is the most important phase since any positive outcome can be construed as good, but being able to compare the benefit to the cost of the investment is paramount.

The benefits of portfolio management lie within its ability to remain agile and adaptive amidst a rapidly changing environment. Rick Hayes Roth once remarked in his lectures that the evolution of the architecture is essential obtaining information superiority. This is difficult to quantify; however, the more pieces that can be exchanged, replaced or incrementally modified will all lend to the strength of the portfolio.

This directive leans towards the use of ROI tools to accomplish its goals but falls short of defining metrics or a template by which to accomplish this portfolio management. This document is not ready for implementation in its current form, but

rather sketches out some broad strokes for IT investment. The tools presented in this paper are applicable to any IT investment and would be useful as a template for quantifying ROI.

2. Length of Time Versus Dollar Value

The relationship between the actual price of the project and decision making approach varies greatly according the amortization period and upfront cost. Therefore, it is imperative to determine the impact of the time value of money relative to the time associated with the project. The continual devaluation of the dollar could result in unrealized losses according to normal market conditions while the IRR could help to determine whether the discount rate is acceptable.

A project's value will be estimated using a DCF valuation, and the opportunity with the highest value, as measured by the resulting NPV, will be chosen (Cook, 2010b). This methodology takes an estimation analysis o the amount and occurrence of the cash flows from the project (Cook, 2010b). The future cash flows are then discounted, which results in the true PV. These present values are then summed, and this sum net of the initial investment outlay is the net present value (NPV). As a result, by rule of thumb if it is positive we accept, if it is negative we reject, but we must keep in mind its volatile correlation to the discount rate. Thus, the NPV metric identifies the proper discount rate or the project's "hurdle rate" to making critical and appropriate decisions. The hurdle rate identifies the smallest return on an investment that is acceptable to the organization (Cook, 2010b). It will also quantify the level of risk involved with the. This is seen through the volatility metric of the cash flow and the mix of financing used in the investment. Therefore, these constant elements give the NPV a great deal of influence when it comes to the decision making process as a starting point to considering a project.

However, there are problems when using NPV solely for conditions that are more uncertain. This is different from risk, where some amount of probability can be factored in to mitigate the affect. The discounted rate covers the risk sufficiently but ignores skew and kurtosis values. In addition, NPV has less of an influence according to management's response in this uncertainty. Major variations in market conditions could derail any

profitability that has been forecasted. Consequently, when managers have flexibility, NPV could underestimate growth opportunities as the company seeks to continually gain a competitive advantage.

The NPV analysis works on the basis of all cash flows occurring with a known level of certainty (Cook, 2010b). This may not be the case in a situation like renting apartments when occupancy varies and leases are cancelled unexpectedly. The discount rate quantifies a certain some level of risk (Samuel & Guclu, 2008). All things being equal, a higher discount rate will result in a reduction in the present value of distant cash flows (Samuel & Guclu, 2008). This part of the NPV reflects the simple time value of money.

The internal rate of return (IRR) valuation is also suitable under risk conditions. The IRR method uses the same basic function as the NPV analysis. The difference becomes apparent as how each method references the unknown variable. With NPV, the discount rate is known and used in the NPV calculation (Samuel & Guclu, 2008). The IRR sets the NPV to zero and then determines the discount rate. The one confusing part of the IRR is that it may generate several solutions to a single problem (Samuel & Guclu, 2008). This problem may arise in projects which alternate between producing net cash inflows and net cash outflows. Thus, any project for which the projected cash flows frequently alternate between producing positive cash flows and negative cash flows may have more than one internal rate of return. This demonstrates a lesser influence on the decision making process where there is too much variance for the IRR to be effective.

As an investment decision tool, the IRR is an internal view of the project (Cook, 2010b). Its reflection in relation to the environment is lessened by strict constant factors. For these reasons, it is not to be applied to measure multiple to projects, but rather one project to determine whether or not the return is acceptable. These hard and fast parameters will direct the influence of the decision makers towards a narrow focus to avoid overestimating the potential return on investment. For example, when one project requires a higher startup investment than another, the first one may have a lower IRR but higher NPV and should be the ultimate choice assuming all other factors being constant.

IRR is based on the reinvestment of interim cash flows in projects that result in equal rates of return (Internal rate of return. (n.d.), 2010). This reinvestment is either a summation of the same project or different one. As a result, “IRR overstates the annual equivalent rate of return for a project whose interim cash flows are reinvested at a rate lower than the calculated IRR” (Internal rate of return, n.d.). The most obvious problem, especially for high IRR projects, is the continuing failure for future projects to yield an equal or higher return as compared to the earning potential of the project. When the calculated IRR is higher than the true reinvestment rate for interim cash flows, the measure will overestimate by a large margin a yearly equal ROI. The IRR makes the assumption that there are other projects, with equally advantageous returns, by which these same investments could realize benefits (Internal rate of return, n.d.). This makes IRR good tool for decision makers. Despite having many cash investments throughout the life cycle of the project, there will only be one cash outflow at the end of the project (Cook, 2010b).

3. The Value Chain

The DoD must adopt a value chain model that embraces a web-like approach to address the various logistical concerns in the Marine Corps and DoD as a whole. A comprehensive solution would go a long way in cost savings and infuse flexibility into the system. The current structure is stovepiped with a sequential interdependency that has many constraints to effectively supply the warfighter as well as meeting the service needs in a holistic manner. This section will examine the current conditions, gaining a competitive advantage, and offer recommendations for modernizing DoD processes.

In class, some key concepts to gaining a competitive advantage were discussed. In the case of the Defense Travel System (DTS) versus Travelocity we learned that even though both systems are robust enough to handle travel requests, Travelocity holds the competitive advantage (Cook, 2010b). The complexity of DTS requires that the user gain training, special interpretation, and even help from a specialist to properly operate it, whereas Travelocity is immediately user friendly. This is the competitive advantage that DoD must adopt to be competitive. The major components that provide the competitive

advantage in most organization processes have four independent elements: scalability, complementary resources and capabilities, relation-specific assets, and knowledge-sharing routines (Ethiraj, Guler, & Singh, 2000).

Information assets that are scalable dominate e-commerce markets through the use of a unique property. Upfront costs are relatively high to produce in the beginning, however; once produced they can be easily and inexpensively reproduced to service any size organization. As a result, those that monopolize the first entry position can rapidly assume a tremendous advantage in the market (Ethiraj et al., 2000). This competitive advantage affords company's the opportunity to saturate the market with products while dictating obsolescence therefore gaining more market share through new products. Apple has been the most successful in bundling its product lines in this scenario. In order to take advantage of this form of dominance on the Internet, organizations must create business models that are able to evolve through scalability. The DoD needs to work towards a joint environment that uses scalability. It is repetitive in nature in areas such as procurement, logistics, financial transactions, unit movement, personnel and equipment tracking. These functions should be webbed together to support all services. Cloud computing is the technology that could facilitate this very well.

Complementary resources and capabilities provide a company with such a flexible business model that can readily use COTS technology to gain superior positions in relation to other competitors (Ethiraj et al., 2000). The Internet has created a level playing field as entry barrier have been lowered. Competitors now have the ability to gain ground quickly and even eventually match the performance of the first mover. Maintaining this superior position in the market may require that organizations who lead in the Internet arena acquire more dominant physical assets to keep their competitors at a distance (Ethiraj et al., 2000). For example, the AOL acquisition of Time Warner's assets may have been driven by this need and they both had to acknowledge the necessity of this merger before their market share was significantly reduced. A joint military environment in the DoD could benefit from this approach as well by forgoing the outsourcing separated approach through embracing such ideas as the integrated logistics concept. This concept literally collects all supplier assets together to allow for the direct pushing of

assets to DoD units. No middle control organization is necessary. A simple web-like configuration could give the supply officer a quick shopping list to choose from according to price or required delivery period. The supply officer then makes specific choices directly from the vendor streamlining a cumbersome process.

Relation-specific assets in an individual firm can dominate the Internet. Despite the business model, the complexities of the network are designed precisely to avoid such dominance. All services are available to any client. As a result, networks of alliances become increasingly important business models on the web. We must recognize that the competitive advantage in e-business is often based on managing these collaborative relationships with key trading partners. Trading partners in a B2G relationship would give the joint DoD environment a sizeable competitive advantage. The relational model for the Internet could bring in a mix of services, specifically scalable and tailored to meet the needs of garrison requirements as well as combat operations. A restructuring of the DoD into a joint entity could eliminate the need for outsourcing as it is done today. Shorter contract periods could also be implemented by a greater number of vendors with improved assets becoming available on a regular basis. This connectivity brings us closer to the industry for a wide range of services. This instant availability of assets is a considerable competitive advantage. Industry can continually stand up and down as required while reducing their costs.

The knowledge sharing routine continues along the same premise as the previous one. The necessity for a strong collaborative relationship has to be emphasized for success (Ethiraj et al., 2000). These relationships realize effective success through the use of collaborators as the conduit for sharing information with one another. This ability to share assists the trading partners in gaining their competitive advantage as a cohesive unit oppose to their competition (Ethiraj et al., 2000). A healthy mix of competition will provide the DoD with low cost options in a myriad of areas. The rules have changed in our global world and the DoD needs to utilize all available resources around the world to facilitate these changes. Politics may be a barrier to pursuing these options, but policies need to be put in place to allow our services to work together with common resources.

4. KVA Creates the ROI Numerator

Since the denominator of KVA is relatively fixed to the market, the benefits of IT implementation are the best area to evaluate the potential success of a system. These benefits have to meet certain criteria in the input transformation output model to understand if value is being added. Managers must first identify if the automation is adding value to the input. Once some input is processed there must be a measureable addition in value once the output is presented. The output of any IT system cannot be equal to the input; otherwise, no value is being added. Therefore, measuring the ratio of learning time over total work time provides a quantitative metric to understand whether or not the KVA on a particular IT system is worth the investment.

Learning time is a key component to developing like terms for evaluation in the KVA method. The application of KVA to the business process gives decision makers a depiction of the business model and processes as they relate to time. Asking the company's subject-matter experts questions as they relate to the time it takes to learn an application and process their total work gives us a reference point with which to compare to workers who do not have the system.

Learning time estimates can be comparable to the outputs of each component process. Each comparison can be used to determine whether the learning time or knowledge is transferred from the human to the system that equals some level of value added. The numerator will justify the cost by demonstrating a better learning time over total work time comparison. The ultimate result is a better competitive advantage as time is reduced in learning, training, and routine tasks are replaced through automation. Keep in mind that marginal costs increased with DTS since the time commitment shifted from lower level employees for travel to everyone of higher ranks. As a result, costs went up instead of down.

Finally, the application of KVA can define and identify the amount of knowledge within each process. The quantification of benefits and learning time give managers the ability to understand the distribution of knowledge throughout the business process. This gives a good estimation of the degree to which knowledge value is being added or not. As

the time requirements of workers are recorded, business practices can be reorganized, redeployed, or reengineered to work in concert with the new IT or to customize the IT to return the desired effect. Either way, the return on knowledge is an application or mirror of the business processes within the organization.

5. Real Options in Software Acquisition

Some have said that moguls such as Donald Trump own nothing but control everything. Similarly, IT acquisition and implementation should be approached with more of a controlling objective rather than an owning objective. The waterfall approach of the past has sought to customize, own, and implement without clearly defining an absolute need for such reckless urgency and risk mitigation or an understanding for future uncertainty. On the other hand, a spiral development approach would yield more of an incremental implementation process by which we can quickly seize success or abandon the opportunity due to failure. Smaller milestones up front give more flexibility to reduce costs. If small amounts are invested up front then small amounts can be risked in investments. The same can be said for the opportunity costs taken or rejected.

For an option, in the case of acquisition, to have a tremendous amount of economic value, there must be market barriers that limit entries in the event of a dynamic contingency. Consequently, zero competition in the product market with no contingency, even if it is extremely positive, will result in a higher NPV (Cook, 2010b). In the end, options become more valuable as the organization obtains exclusive rights; for instance, when the DoD and only the DoD can take advantage of the contingency. On the other hand, options decrease in value as the barriers are lessened and the competition becomes fierce.

The basic value of an asset makes the assumption that value will increase in the future, which makes the right to buy at a fixed price (calls) extremely advantageous. On the other hand, there will be less value associated with the right to sell at a fixed price (puts) as the asset becomes more valuable (Cook, 2010b). The same is true for acquisition programs where the increase in value makes the option more attractive, where the abandonment to sell is less attractive. In addition, increased value causes value is due the

variance in value that is experienced with both calls and puts. They become more valuable, since all options have limited risks and depend upon price volatility for positive returns, but time space becomes the more valuable determinant in this case (Cook, 2010b). Acquisitions are no different as the IT environment is ever-changing and the future is uncertain. Assuming options that are reliable and responsive for the long term is the best strategy. Lastly, the anticipated return on an investment, which may decrease the dividend aspect of an investment, reduces the value of calls while increasing the value of puts (Cook, 2010b). Expected value is the correlation to acquisitions where the small benefits are realized or not according to assumptions. Expected success means moving forward with purchases and implementation while early failure says to accept those initial losses and stop implementation.

6. IT Decision Making

Ross and Weil suggest that the first three questions are related to the company's strategy. These obviously must be answered by the senior management who develop the strategy. The second set of three may be answered by a systems analyst who is a subject-matter expert. This is not to say that they are less important or should be abdicated, but rather that they are less important than the first three.

It is the belief of the author that all of the approaches that discussed in class play a part in some form during the IT decision analysis, whether it is in making a quick assessment of future value with an NPV assessment or non-traditional approach with KVA. However, when it comes to evaluating the IT systems by senior management, like-terms must be used to express the return on investment. KVA is the calculation that can be carried into all levels of decision making to demonstrate the benefits as they relate to costs.

Only senior managers can identify the level of spending as it relates to the rest of the organization or future ventures. Businesses roughly spend about \$2 trillion a year on IT. This often accounts for half of their expenditures (Gartner Research, 2005). IT spending accounted for 5% of capital expenditures in 1965, 15% in the early 80s, and 30% in the early 90s (Gartner Research, 2005). This may have been due to the latest

advancements, but many companies make these investments in IT with the hope that they will return some strategic advantage over their competitors. IT should no longer be viewed as the sole proprietor or maintainer of the strategic competitive advantage since IT has morphed into a commodity. No commodity, throughout history has ever produced this result autonomously to create this edge (Gartner Research, 2005). Only when IT supports the company strategy can it be successful. KVA allows senior managers to see the overarching strategy with a learning time over total work time cost comparison, the common terms needed to create the ceiling and floor price for IT spending.

IT personnel are not the experts, nor are they the decision makers who intimately know the ins and outs of the business processes. Senior management knows the business processes and can reengineer them or reorganize them to fit the IT solution, or vice versa. Knowing the right approach to aligning the structure of the company with IT is essential. For instance, some processes may be autonomous while others are dependent. Understanding these interdependencies will help structure the company to be reciprocal or pool the knowledge base within one section. Ross and Weil also spoke of being mindful of centralized and decentralized implementation. Only senior managers can take this overview of the company to apply the correct metric for return on investment. Once again, the flexibility of KVA is shown as it is able to recognize the transfer of knowledge. If automation assumes this knowledge where learning time is decreased, then managers can realize a need to reduce manpower. Consequently, if automation has not transferred knowledge but performs well, then reorganization may be necessary to realize the value added through the system.

Understanding the capabilities that need to be available throughout the company is essential to capabilities planning. The functional areas that can be shared or consolidated for communal accessibility in a centralized or decentralized format must be evaluated. IT personnel are in no position to make this decision. The skill set that needs to be reconfigured to work in a hybrid matrix type structure is a decision that only senior managers can make. This may include physical relocation, business unit or business unit manager changes, or an increase in commitment to sink or swim with the outcome. There is a period of backward compatibility that needs to be maintained in transition while

deciding whether or not to pursue better performance. There is a tradeoff here that can only be answered by measuring the return on knowledge as it relates to the global employment of the IT solution. This is not a vacuum decision that assumes the best ERP on the shelf can deliver in any situation. Managers must weigh these decisions as they total work time together. If learning time does increase, there must be a sizeable reduction in total work time. This dynamic is most likely to be seen in aggregate as it pertains to doing more with less. The bottom line is that the return on investment is not to only be realized in dollars and cents, but rather, the overall benefits that are returned throughout the organization.

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III. WAN OPTIMIZATION WITH CASCADE SETUP

A. OPEN SYSTEM INTERCONNECT (OSI) MODEL EXPLAINED

Similar to the protocol practices used for the Internet, the OSI model establishes the framework for network connectivity (Kurose & Ross, 2008). This protocol stack helps to organize networks through the use of seven layers. These seven layers include: the application layer, the presentation layer, the session layer, the transport layer, the network layer, the data link layer, and the physical layer (Kurose & Ross, 2008). The first three layers process data whereas the last four layers process segments, packets, frames, and bits respectively. Each layer exhibits an independent function to ensure information is routed successfully throughout the network.

The individual layers exhibit an independent functionality to ensure information is routed successfully throughout the network. This layer concept also aids in troubleshooting by compartmentalizing issues for quicker identification and resolution from the beginning through the end (Kurose & Ross, 2008). At the top, the application layer is extremely important as it controls the communication between computers. It uses applications such as web browsers to communicate with other systems while enforcing the protocols such as FTP. The presentation layer assists the application layer by formatting and encrypting data to make it useable. HTML is used at this level to allow a seamless international interchange capability. The session layer initiates and terminates the network connections. Protocols such as the remote procedure call (RPC) and the structure query language (SQL) are used here to request services between the two systems during each session. Once the data has been configured in the first three layers it is now ready to be transported. The transport layer arranges the data into packets that are sent out according to transmission control protocol (TCP) and user datagram protocols (UDP). The network layer takes these packets to ensure that the best route is used from transmission. This routing is facilitated by routers and the Internet protocol (IP) to ensure proper addressing procedures. The data link layer is responsible for breaking down the packets into frames. This layer composes physical addressing for the physical layer to use it. Finally, the physical layer comprises the cables and connections involved with each

transmission. It also decodes the bit instructions delivered in each packet. As a result, the communication is encompassed by the physical layer.

This layer concept also aids in troubleshooting by compartmentalizing issues for quicker identification and resolution. WAN optimization software works in the application layer and is supported and optimized through the activity of the presentation layer. These two layers allow the software to continuously monitor the system with complete visibility of the network. The protocols or rules for the network reside at the application layer. The Internet has protocols such as HTTP, FTP, and the popular SMTP that support webmail services. Therefore, to control the flow of information and gain a connection to the broad functionality of the network, one must maintain visibility of the activities in the application layer. Packets of information flow through this layer directly impacting the end user. Thus, performance issues of latency or quality immediately impact the network. These interruptions could be taken care of on a case-by-case basis as troubleshooting becomes necessary or as issues present themselves through alert efforts.

B. THE IMPACT OF WAN OPTIMIZATION

Every organization that operates through the use of a WAN must be concerned about optimizing its services. The benefits are enumerable from reducing storage space, increasing speed, and centralized data center control (Metzler, 2007). Metzler suggests that IT managers take WAN optimization on as priority to gain superiority in this area.

The main techniques of WAN optimization lie within caching, compression, congestion control, differencing, forward error correction, and quality of service (Metzler, 2007). Caching is access to the reservoir of local memory. It is faster to retrieve than returning to the main database for each service but runs the risk of missing the identical or current information required. Compression works to make the file sizes smaller before transport. This has a direct link to reducing latency as packets are quickly decoded for the end users. Congestion control seeks to reduce the traffic burden on the network by not sending more information than it can reasonably handle. By using the TCP these transmission windows can be controlled according to user demand. Differencing is also known as de-duplication as it avoids transmitting whole files for each

request. Instead, its primary purpose is to only send the changes. Differencing often runs the risk of increasing the amount of cache needed on a daily basis since only the changes are transmitted. Forward error correction is a function of the physical layer in the OSI model. It provides an extra packet of redundant information to ensure full and complete data is sent. This prevents the need for a full retransmission of individual packets. Finally, the quality of service (QOS) technique controls the manner in which traffic is managed by giving priority treatment to some services while denying or queuing others. For example, voice tends to receive this type of preferential treatment simply because it requires more bandwidth. In the end, choosing the right technique or combination has the potential of significant cost savings while optimizing the entire network. Metzler's (2007) table (Figure 11) shows the problems that the WAN is experiencing and the optimization techniques that can prevent them from occurring.

WAN Characteristic	WAN Optimization Techniques
Insufficient Bandwidth	Data Reduction: Data Compression Differencing (aka, de-duplication) Caching
High Latency	Protocol Acceleration: TCP HTTP CIFS NFS MAPI Mitigate Round-trip Time Request Prediction Response Spoofing
Packet Loss	Congestion Control Forward Error Correction (FEC)
Network Contention	Quality of Service (QOS)

Figure 11. WAN Optimization Troubleshooting Source (From Metzler, 2007)

C. CASCADE SETUP

Cascade is a WAN optimization software used to provide total visibility of the network. Its features work through the application layer to allow wide range management and visibility of the network. The following Cascade setup information was derived from a meeting with Riverbed Technology Defense Contractors on August 27, 2010.

As discussed, if there is an over abundance of traffic on the network, latency in applications begins to slow down the network. When the applications are not performing well then the network may not perform very well. Cascade provides the visibility to see where these problems are occurring. There are three things that Cascade does to optimize the WAN. It manages application performance, it manages data capacity and data links, and it provides a “cloud” by which the data center can consolidate resources.

Cascade’s architecture primarily utilizes three logical pieces that can reside in any hardware: the sensor, the gateway, and the profiler. Cascade is agentless, meaning that nothing is loaded on to the network or on the individual clients. It plugs into the network and monitors or “sniffs” its activity. The sensor piece plugs into a network span port to capture flow of data at layer 7 level. This helps to understand the conversation flows across the network to see traffic that is occurring and who is making the demand from server to end user. The gateway is a flow collector. It captures this data at layer 4 level. Both of these functions are fed into the profiler where all current and historical data is stored. The profiler produces reports for managers and tech personnel alike to understand how the network is performing. This is information specific meaning that there is a lot of de-duplication performed before it reaches this repository. The profiler also has a flexible backup system. The profiler does not rely on a disk, but rather a sand card of terabyte information can be retrieved and stored from the initial installation to its termination.

Cascade can be set up in an hour or two, depending on the size of the organization. The monitoring of the network can occur within a week or two depending on whether or not the routine determinants are available to find the routine activity level for the network baseline. A weekend setup would not be sufficient. This baseline will be used to determine the abnormalities and necessary troubleshooting to optimize the

network. The cost is roughly \$50,000 plus a 15% annual fee for maintenance. One application can facilitate a normal Marine Corps Base without any additional cost.

The report output from the profiler is ad hoc, or dash-board centric as Riverbed refers to it. This means that reports can be tailored to share the relevant problems to the proper tech level or even provide the IT manager with the worst looming problems. Application specific reports or network reports are available to distinguish between system failures and user demand activity. Often, networks run unaware of the additional traffic that is interfering with services on their networks. Cascade identifies this activity so it can be removed. The visibility is real-time so that there is no delay once activity goes out of bounds.

Cascade problems alert tech personnel with notifications that a service is slowing down or no longer available. Typical notifications may take much longer if the data center waited for user response. Cascade can quickly identify the server where the problem is occurring or which user is conducting unusual operations that are significantly degrading the functionality of the network. A graphical depiction of the activity is available to quickly identify the problem. This may allow an additional level of security if a high level of server access is being required along with virus detection in the application layer.

D. DATA ANALYSIS: BPR OF THE NMCI HELPDESK PROCESS AND ITS IMPACT ON WAN OPTIMIZATION

1. Process Modeling Explained

The modeling software used to conduct the BPR is called Savvion. It is real-time simulation software that has the capability to step through a given process while detecting bottlenecks, rework, and other constraints. Hourly rates are input to determine the cost associated with certain portions of the process. Savvion uses these types of variables to determine the total processing time, delay, and potential cost savings realized with the implementation of an IT solution. Consider four processes of mail delivery from collection, to sorting, transporting, to final delivery. Figure 12 represents the four processes of a mail delivery post to further illustrate process modeling.

2. Current Process (AS-IS)

The NMCI Helpdesk is responsible for providing Marine Corps Base (MCB) Quantico, Marine Corps Combat Development Command (MCCDC), Marine Corps Community Services (MCCS14), Marine Security Battalion (MSGBn) and other network users with a customer based focus, and the first point of contact to resolve computer related issues regarding software and hardware on the NIPR and SIPR networks. In responding to issues, a trouble ticket will be created and internally assigned and tracked for resolution as soon as possible.

The help desk is responsible for numerous requests, which need to be researched and filtered through:

- Improving communication processes
- Shortening service response times
- Increasing “first contact” resolution rate
- Establishing user accounts, set IDs, user profiles, and user software and hardware needs in making the transition from the legacy network to the NMCI network and then maintaining the NMCI network.
- Creating multiple types of reports to analyze and maintain seat requirements by organization. CTRs will input daily to the NMCI Enterprise Tool (NET) ordering system. This requires knowledge of database applications and user base. NET will be validated with users periodically for accuracy.
- Investigating and resolving user questions, problems, and needs by telephone under the NMCI contract and involving Move/Add/Change (MAC) requests. Users/Information System Coordinators (ISCs) will complete the form on the MAC form and the ISC will in turn check the information for accuracy and completeness and submit it to the NMCI Service Request Management (SRM) Team in the appropriate level workgroup.
-

The following types of MAC requests are also available.

- New User Account
- Deactivate User Account
- Update User Profile
- Blackberry Transfer
- Install Software
- Manage Workgroup Tools (distribution lists, organizational mailboxes, etc.)
- Move Computer from User to User
- Move User with Computer.

The following assumptions formed the help desk model (pay scale is based upon a forty-hour work week by fifty-two weeks a year).

Performers (AS-IS):

IT Operators:

Availability: 1/shift

Pay Rate: \$11.16/h (G3-step 3)

Work Week: 40h/week

Report Rate: 2 calls/h

Diagnosis: 15min (includes call, diagnosis & problem routing)\

Their training includes eight hours of in-class training and twenty-four hours of on-the-job training.

Level 1 Technician:

Availability: 2/shift

Pay Rate: \$16.60/h (G6-step 5)

Work Week: 40h/week

Issue Rate: 60% of network issue calls

Diagnose: 40min (includes repair & report generation)

Their training includes thirty hours of in-class training and fifty hours of on-the-job training.

They receive two hours OJT to complete the reports required.

Level 2 Technician:

Availability: 2/shift
Pay Rate: \$19.00/h (G7-step 6)
Work Week: 40h/week
Issue Rate: 30% of network issue calls
Diagnose: 2h (includes repair & report generation)

Their training includes thirty hours of in-class training and fifty hours of on-the-job training.

They receive two hours OJT to complete the reports required.

Level 3 Technician:

Availability: 1/shift
Pay Rate: \$21.64/h (G8-step 7)
Work Week: 40h/week
Issue Rate: 8% of network issue calls
Diagnose: 18h (includes repair & report generation)

They receive fifty hours of in-class training and seventy hours OJT.

They receive two hours OJT to complete the reports required.

IT Manager:

Availability: 1/shift
Pay Rate: \$28.91/h (G11-step 7)
Work Week: 40h/week
Issue Rate: 2% of network issue calls
Diagnose: 18h (includes repair or outsourcing)
They receive thirty-two hours of in-class training above and beyond the Level 3 Technician training.

The following model is a standard AS-IS layout for the help desk design.

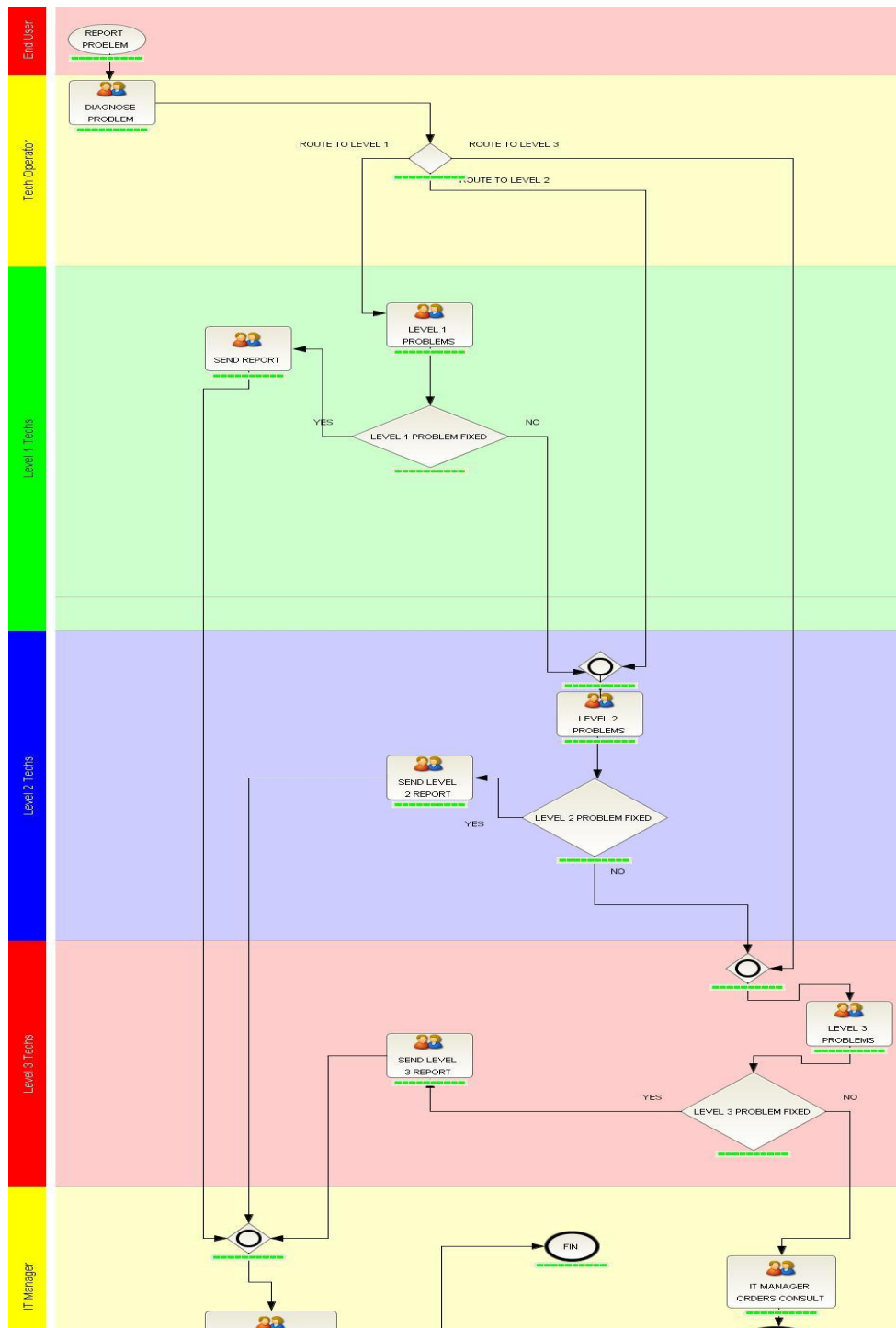


Figure 14. Help Desk AS-IS Model

Figure 15 displays the results from the AS-IS Model in Savvion. The findings are relatively straight forward. The points of interest include the long duration to complete the process, the tremendous wait time for each performer, the total time, and the varying levels of work time. Some performers are overworked, such as level three techs, and others are not as busy, such as the tech operator.

Simulation Results for WAN_Optimization_V2_0 - (default)								
Duration	346:35:00 Time							
Process Time And Cost								
Process	Scenario	Instance	Total Cost (\$)	Waiting Time (Time)	Total Time (Time)			
WAN_Optimization_V2_0	(default)	160	12,615.90	4791:45:00	5402:00:00			
Grand Total			12615.9	4791:45:00	5402:00:00			
WAN_Optimization_V2_0								
Scenario	(default)							
Instances	160							
Activity	Performer	Occurs	Waiting Time (Time)	Time to Complete (Time)	Total Time (Time)	WorkTime	Fired/Hour	AWT
DIAGNOSE PROBLEM	Tech Operator	160	4:15:00	40:00:00	44:15:00	40.00	2.00	0.250
IT MANAGER ORDERS CONSULT	IT Manager	1	0:10:00	6:00:00	6:10:00	6.00	0.01	6.000
LEVEL 1 PROBLEMS	Any member of Level 1 Techs	96	0:05:00	56:00:00	56:05:00	56.00	1.20	0.583
LEVEL 2 PROBLEMS	Any member of Level 2 Techs	53	1:25:00	101:35:00	103:00:00	101.58	0.66	1.917
LEVEL 3 PROBLEMS	Level 3 Techs	19	2298:00:00	340:25:00	2638:25:00	340.42	0.24	17.917
MANAGER REVIEWS REPORTS	IT Manager	159	108:45:00	53:00:00	161:45:00	53.00	1.99	0.333
SEND LEVEL 2 REPORT	Any member of Level 2 Techs	50	2:50:00	4:10:00	7:00:00	4.17	0.63	0.083
SEND LEVEL 3 REPORT	Level 3 Techs	18	2376:00:00	1:30:00	2377:30:00	1.50	0.23	0.083
SEND REPORT	Any member of Level 1 Techs	91	0:15:00	7:35:00	7:50:00	7.58	1.14	0.083

Figure 15. Savvion AS-IS Model Results

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IV. KNOWLEDGE VALUE ANALYSIS

Knowledge management (KM) has come to be known as the manager's tool to understanding and effectively employing human and IT resources in an organization (Housel & Bell, 2001). The value of information is difficult to observe outside of prototyping; however, the knowledge impact can be modeled in Savvion as personnel are reduced and processes are streamlined. This analysis results in the return on knowledge (ROK) of the IT solution to determine whether or not it is worth the investment. As a result, ROI and ROK may be used interchangeably during this analysis.

The knowledge value analysis is based upon the theories of Dr. Housel and Dr. Bell (2001). Housel suggests that many of the common return on investment calculations are simply insufficient and ineffective to determine the validity of adopting IT solutions. For example, payback period, options valuations, and NPV calculations are only successful in determining relevant cost associated with the decision but fail to identify the numerator for quantifying the return on investment. This numerator has to transform the anticipated benefits and reengineered effects of the IT solution into a number over cost to forecast the ROI. The spreadsheet shown in Table 4 was done in cooperation with my colleague Joanna Kalvig. It demonstrates the knowledge value aspects of adopting Cascade for WAN optimization.

	Processes	Actual Learning Time	Nominal Learning Time
		Hours	Hours
Tech Operator	DIAGNOSE PROBLEM	24	54
IT Manager	IT MANAGER ORDERS CONSULT	32	2
Any member of Level 1 Techs	LEVEL 1 PROBLEMS	80	4
Any member of Level 2 Techs	LEVEL 2 PROBLEMS	80	7
Level 3 Techs	LEVEL 3 PROBLEMS	120	23
IT Manager	MANAGER REVIEWS REPORTS	6	2
Any member of Level 2 Techs	SEND LEVEL 2 REPORT	2	3
Level 3 Techs	SEND LEVEL 3 REPORT	2	3
Any member of Level 1 Techs	SEND REPORT	2	2
	Sum	348	100
	Correlation	83%	

Table 4. KVA Analysis Spreadsheet

The first step in this AS-IS analysis was to list the key personnel and the processes they perform. Research was gathered to determine how long these activities took to complete. This time is referred to as learning time (Housel & Bell, 2001). The NLT was the best guess or training response, whereas the ALT was the actual time for the current personnel to complete their tasks. The correlation verified that the ALT and NLT was within a suitable confidence interval.

Times Fired	#PEOPLE	%IT	Total Learning Time	Total Output per hour	Actual Work Time	Actual Activity time per hour
per			Hours		Hours	
2.00	1	10%	26.40	52.80	0.25	50%
0.01	1	10%	35.20	0.44	6.00	8%
0.60	2	10%	88.00	105.60	0.58	35%
0.33	2	10%	88.00	58.30	1.92	63%
0.24	1	10%	132.00	31.35	17.92	426%
1.99	1	10%	6.60	13.12	0.33	66%
0.31	2	10%	2.20	1.38	0.08	3%
0.23	1	10%	2.20	0.50	0.08	2%
0.57	2	10%	2.20	2.50	0.08	5%
N/A	N/A	N/A	383	266	N/A	N/A

Table 5. KVA Analysis (part one)

Table 5 shows times fired (referring to the number of incidents in this case), personnel involved at each stage, and the current estimate IT assistance in place. The TLT is calculated as $ALT + (ALT * \%IT)$. Total output = (Times fired)*(#people)*(TLT). AWT is a calculation derived from the Savvion report to show how long the process took to work. Actual activity time is a product of (times fired)*(AWT).

Total Input per Hour	Cost per hour	NUM	DEN	ROK
0.50	\$ 11.16	\$ 17.87	\$ 5.58	320%
0.08	\$ 28.91	\$ 0.15	\$ 2.17	7%
0.70	\$ 16.60	\$ 35.73	\$ 11.62	308%
1.27	\$ 19.00	\$ 19.73	\$ 24.13	82%
4.26	\$ 21.64	\$ 10.61	\$ 92.08	12%
0.66	\$ 28.91	\$ 4.44	\$ 19.15	23%
0.05	\$ 19.00	\$ 0.47	\$ 0.99	47%
0.02	\$ 21.64	\$ 0.17	\$ 0.41	41%
0.09	\$ 16.60	\$ 0.85	\$ 1.57	54%
7.6	N/A	\$ 90.00	\$ 157.70	57%

Table 6. KVA Analysis (part two)

Table 6 shows the input per hour and cost per hour. Input = (times fired)*(#people)*(AWT). The cost per hour is the hourly wage. The NUM is extremely important as it is a function of percentage of output. The calculation is the output per hour for the individual over the sum total of output multiplied by revenue per hour. The NUM captures the total benefit of implementing the IT solution. The numerator and the denominator calculate the ROK or return on investment for this process. The use of the reduction makes the ROK understandable as a factor of improvement in the process.

A. BPR GOALS

The above analysis exposed many problems in the AS-IS help desk model. It was slow and cumbersome to solve issues on the network. The following goals formed the expectation for Cascade in the TO-BE model:

1. The current process had a total of 5,402 hours of which 4,791 are wait hours. This means only 611 hours are actual work. Work accounts for 11.3% of the total time. The goal is to eliminate all wait time and make the work account for 100% of total time.

2. Level 3 techs have a 98%+ utilization rate, a reduction to less than 70% with no increase in total cost should be attainable.
3. Increase the workload to 200 calls per week, while still meeting all of the above reengineering goals.

B. THE TO-BE PROCESS BACKGROUND

Performers (TO-BE):

Cascade (WAN OP Tool):

Availability: 1/all shifts

Pay Rate: N/A

Work Week: N/A

Report Rate: N/A

Diagnosis: N/A

Easy-Level Technician:

Availability: 2/shift

Pay Rate: \$16.60/h (G6-step 5)

Work Week: 40h/week

Issue Rate: 85% of network issue calls

Diagnose: 10min +/-2min

Difficult-Level Technician:

Availability: 3/shift

Pay Rate: \$19.00/h (G7-step 6)

Work Week: 40h/week

Issue Rate: 15% of network issue calls (plus 5% of Easy-Level)

Diagnose: 2h +/-45min

IT Manager:

Availability: 1/shift

Pay Rate: \$28.91/h (G11-step 7)

Work Week: 40h/week

Issue Rate: 5% all Difficult-Level network issue calls

Diagnose: 3h +/-1 hr

The business process reengineering of the WAN optimization involved the addition of a product called Cascade. Cascade is a software package that is combined with a network sniffer. These two functions work in unison to create a baseline network usage and then constantly monitor the network to discover delays and errors. The Cascade software package allows network administrators to receive pinpointed

information on delays and errors with details of the conditions of the delay. This knowledge allows the technicians to skip the majority of the diagnostic work associated with routine network trouble calls reported to the help desk. Cascade's unique and non-invasive protocol allows the network manager to set conditions on user access, as well as receive alerts regarding activity from any user, server or other device on the network that is exhibiting activity outside of its normal baseline activity. The system requires little to no downtime for actual installation and has no added security requirements because it employs non-invasive listening devices whose sole purpose is to simply gather data usage patterns.

The learning time for Cascade is approximately one full week. This is the time necessary for the software to learn the usage patterns of the network and develop its baseline of operations. This equates to 168 hours of actual learning time. As Cascade completed the majority of the work in the new system, it equates to 87% of the nominal learning time for the help desk process. The initial investment to bring Cascade online is approximately \$50,000. Thereafter, a maintenance fee of approximately \$15,000 per year is required to keep the software up-to-date and for maintenance on the installed listening devices. For the first year of operation, the hourly wage of cascade comes to approximately \$6.56 per hour.

C. SYSTEM REENGINEERING

The Cascade system automatically sorts incoming errors into two classes: EASY and DIFFICULT. The errors are then routed to the appropriate desk with detailed analysis of the error involved to include: location of error, duration of error, equipment involved, user involved and determination of corrective action. This detailed breakdown of errors alleviates repair technicians from spending several minutes to hours determining the exact issue the user is experiencing and how best to correct the problem. Cascade also generates a continuous log of network errors and corrective actions necessary eliminating the necessity for technicians to generate reports for each call received.

We removed the Technician in charge of routing incoming trouble calls and replaced his position with the Cascade system. This software consistently diagnoses 85%

of the initial errors on the network as an EASY problem and routes the complete trouble ticket to the EASY problem team. Because Cascade detects and analyzes the error, the EASY team needs only perform the actual steps to rectify the issue. The requirements to actually perform trouble-shooting are reduced, as is the knowledge necessary to complete the required fix. Of all the errors received on the EASY team, only 5% cannot be fixed and must be routed to the DIFFICULT team. The DIFFICULT team receives 15% of all initial errors reported in the system. Once again, the amount of time for them to complete these errors has been significantly reduced as the Cascade system has pinpointed the error and sent all pertinent repair information to the team for correction. Any error not correctable at this level is then routed to the IT Manager for outsourcing.

To completely reduce the wait time, another Difficult Problem Technician was added. The incredible item of notice is that by adding another technician at this level we reduced our overall costs by approximately \$355.42, reduced our wait time by 2 hours and 15 minutes, and reduced our total time to complete 200 instances by 15 hours and 46 minutes.

D. BENEFITS

Cascade allowed us to completely eliminate the Level 3 Technician, who had a base hourly wage of \$21.64, and replace him with a Level 2 Technician with an hourly wage of \$19.00—a \$3.64 per hour savings. By replacing the Technician Operator with Cascade, we saw an hourly wage reduction of the full amount, as the cost of Cascade is a sunken cost.

Overall costs were significantly reduced. Originally, the system completed 160 instances in two weeks. This cost the company \$12,615.90, had 4,791 hours and 45 minutes in wait time, and took a total of 5,402 hours to complete. With the implementation of Cascade, costs were reduced to \$1,940.20, wait time was eliminated, and time to complete 200 instances in two weeks was only 102 hours and 39 minutes. This is a reduction of \$10,675.70 in costs. Combine the reductions in cost

with the reduction in salaries and Cascade pays for itself within the first year. The following model shown in Figure 16 is a standard TO-BE layout for the reengineered help desk design.

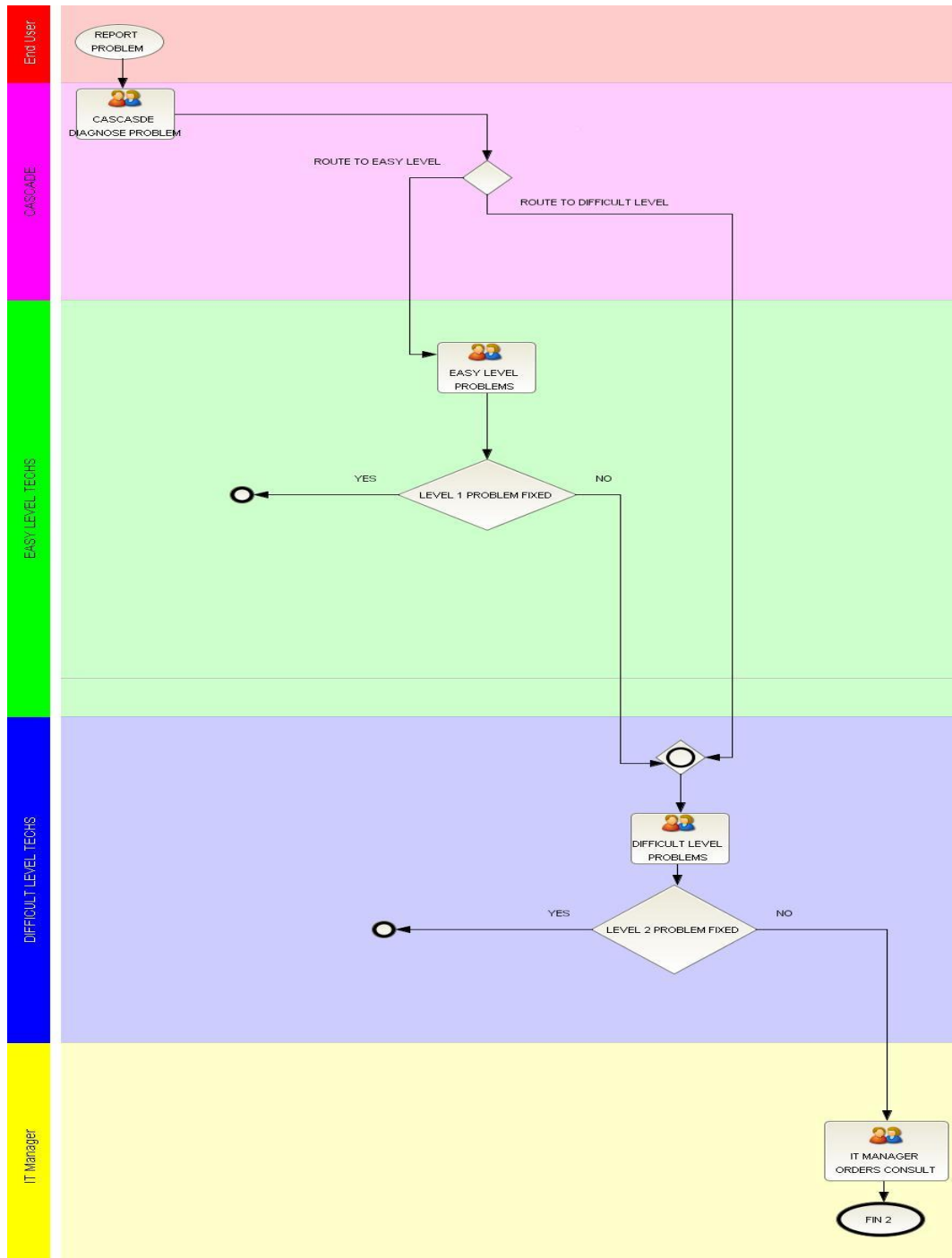


Figure 16. Help Desk TO-BE Model With Cascade

Table 7 demonstrates the impact of Cascade on the help desk process. Optimizing the WAN allows the manager to eliminate a level tech position to increase personnel in another. The duration time is now within an acceptable range, there is no wait time, while increasing the number of instances that could be handled in the TO-BE model.

Simulation Results					
Duration	76:47:10 Time				
Process Time And Cost					
Process	Scenario	Instances	Total Cost	Waiting Time (Time)	Total Time (Time)
WAN_Optimization_V2_0	(default)	200	1940.2	0:00:00	102:39:20
WAN_Optimization_V2_0					
Scenario	(default)				
Instances	200				
Activity	Performer	Occurs	Waiting Time (Time)	Time To Complete (Time)	Total Time (Time)
CASCADE DIAGNOSE PROBLEM	CASCADE WAN OPTIMIZER	200	0:00:00	0:33:20	0:33:20
DIFFICULT LEVEL PROBLEMS	Any member of DIFFICULT LEVEL TECHS	39	0:00:00	67:37:00	67:37:00
EASY LEVEL PROBLEMS	Any member of EASY LEVEL TECHS	170	0:00:00	27:44:10	27:44:10
IT MANAGER ORDERS CONSULT	IT Manager	2	0:00:00	6:44:50	6:44:50
Resource	Unit	Cost/Unit	Threshold	Usage	Cost
Any member of DIFFICULT LEVEL TECHS	Hour	19	0	67	1273
CASCADE WAN OPTIMIZER	Hour	0	0	0	0
IT Manager	Hour	28.91	0	6	173.46
Any member of EASY LEVEL TECHS	Hour	16.6	0	27	448.2
Performers Queue Length and Utilization					
Name	Average	Min	Max	Utilized(%)	Idle(%)
Value of 'Creator'	0	0	0	0	100
Generic	0	0	0	0	100
Any member of DIFFICULT LEVEL TECHS	0	0	0	29.35	70.65
End User	0	0	0	0	100
Tech Operator	0	0	0	0	100
CASCADE WAN OPTIMIZER	0	0	0	0.72	99.28
IT Manager	0	0	0	8.79	91.21
Any member of EASY LEVEL TECHS	0	0	0	18.06	81.94
Bottlenecks					
Process	Activity	Performer	Avg Queue Length	Min Queue Length	Max Queue Length
Note:					
Red-marked Waiting Time values indicates "Activity has waiting time"					
Red-marked Usage values indicates "Usage crossed threshold"					

Table 7. TO-BE Savvion Model Results

E. MARKET COMPARABLE

Canyon Crow is a suitable market comparable for this help desk BPR. It is comprised of the same size and structure as the average military command IT support center. Canyon Crow adopted the Outlook Help Desk System to automate a portion of their process. They realized gains throughout the section but failed to increase knowledge

value or reduce personnel throughout the process. The addition of Outlook exemplifies the limited aspects of IT solutions towards productivity. Automation does not automatically result in a return on investment no matter how little or big the investment amount. For the purpose of this calculation, we assumed that the help desk supports 500 internal users, 550 personal computers, the company PBX and electrical installation maintenance. The help desk has a staff of four techs and an IT manager. The help desk averages two calls per hour, per tech, or sixteen calls per 8-hour-day per tech. The following calculation (Figure 17) also works for external support except that the average time to handle a request would probably be higher.

imperative that this process support the optimization effort as quickly as possible. Having the proper visibility of all aspects of the WAN was found to make the biggest difference. The addition of a major enhancing IT solution like Cascade allowed the business process to be reengineered from the current manual condition to a streamlined process eliminating the need for the operator position.

The AS-IS model followed a manual process for error detection. Users reported possible issues after reaching some point of intolerable annoyance. This user report could take hours or even days before the help desk is made aware of the network problems further delaying the technical response. Calls received by the help desk operator were then diagnosed, which could take a considerable amount of time if multiple problems occurred simultaneously or the source of the problem was difficult to diagnose. As a result, this part of the help desk needed to be reengineered to eliminate these bottlenecks.

The TO-BE model incorporated Cascade to handle the aforementioned problems. Cascade collects network flow data and enhances it with application and user identification, behavioral analytics, and network performance metrics. Because it creates groupings based on logical business categories, Cascade presents a complex infrastructure in a business context. Its predefined and customizable behavioral analytics enable users to identify performance, availability, and security issues before they disrupt business services. Complete and accurate usage and dependency data provide the key inputs for making the right optimization and change management decisions. This reduces human error and mitigates much of the rework that would be needed otherwise. Cascade's full visibility identified network issues without user input, reduced the report review time for the IT Manager, and allowed the workforce to shift one tech to the difficult area, which further reduced work time. Cascade demonstrated a significant return on investment.

F. FUTURE WORK

1. Lean Maintenance

Lean maintenance refers to producing more with less while reducing downtime in the business process (Anon, 2004). The maintenance is lean in terms of the time required

to conduct the procedure again. This can be invaluable as productivity continues to increase and maintenance approaches zero. Two specific areas focus on accomplishing this goal by measuring the impact that the average occurrence or reoccurrence of maintenance interruptions present. They are Mean Time Between Failures (MTBF) and Mean Time To Repair (MTTR).

MTBF is calculated as (Total time up) / (number of failures). As each cycle is processed, there would be failures associated with the down time that is more acceptable than others, as well as failures that increase the overall level of risk. Consider optimizing the WAN as a maintenance function of the help desk. The total time that the users work at optimal levels positively support productivity in the organization. Each troubleshooting effort is an indication of the degradation in the network and further strains the utilization level of the help desk technicians.

MTTR is calculated as (Total down time) / (number of breakdowns). Each cycle of down time is measured from the detection to down time and the eventual repair. The time it takes to repair can be used by decision makers to determine if the MTTR is at an acceptable level or not. It also identifies the feasibility of adopting an IT solution. In the case of WAN optimization, the IT solution that uses behavioral analysis and drill down features can quickly separate weaknesses in the network from failures. This time is critical in achieving a lean maintenance cycle. Both MTBF and MTTR could be used in a comparative analysis of several WAN optimization software products. Research would demonstrate the benefits of a lean maintenance approach to further delineate these IT solutions and recommend adoption.

2. Full Implementation

Full implementation is also recommended at this point. Previous portfolio research has already been conducted that finds that Cascade outperformed the competition. This research identifies Cascade's ability to reengineer the help desk process, eliminating positions while making the technicians more proactive in

troubleshooting the network. A pilot program or full implementation could be done immediately with a network interface card (NIC). There is no unsecure intrusive activity required.

V. CONCLUSION

In conclusion, Riverbed Cascade provides several benefits as previously stated in this thesis. But it also provides for some areas of concern. First, the program monitors the traffic on the network to determine patterns of use and then develops a monitoring protocol to determine whether there is any traffic outside of the normal patterns. The system will generate alerts to key personnel with the details of the abnormal activity. With the military operating erratically and often in nonstandard patterns, this monitoring system has the potential to raise unnecessary alerts to activities that are not outside the norm of military working patterns.

Security via a VPN is a necessary procedure that should not be circumvented when accessing the network from a remote location. By not utilizing the VPN for access, the possibility of allowing unauthorized personnel access to the network exists. Personnel who access the network directly and are not made to authenticate their credentials via a VPN gateway will not be detected by the Riverbed monitoring system as an anomaly and will, therefore, have free reign of all applications on the network.

The Riverbed monitoring system will generate alerts based on a preset criteria of user activity. If personnel on the system fall outside these predefined limits, the system will alert the network administrators that a breach of the system has occurred or that a particular operating parameter of the network is outside the limits. However, the system's work ends there. The actual identifications and corrections to the network through either investigation of the personnel accessing the network or through correction of network settings must be accomplished by actual people in the network administration office or by security personnel working at each location.

Riverbed can provide metrics showing the rate at which application data is traversing the network, a per-connection throughput measurement, and a measurement of the true speed a user can achieve when performing application transactions. This has the potential for the development of new metrics that monitor the speed in which a user performs an individual task. These new metrics would be a very inaccurate way to

determine productivity in the work place. Utilizing the concept that all processes can be measured via each individual task assumes the processes are extremely standardized and require little variation on the user's part. While some aspects of the tasks performed in the military fall under this description, many other tasks do not. Measuring user's productivity under these metrics puts the command at risk for identifying certain users as ineffective or inefficient and grading them as such.

The cost for implementing the Riverbed monitoring system would be a substantial investment, as there is an initial installation fee and then a yearly maintenance fee. Each system utilized will fall under a different contract. While some of the cost may be deferred through the reduction in personnel necessary to monitor the network, care must be given to ensure the leases for the monitoring system will truly show a return on investment.

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